High-speed Input and Pulse Output Features

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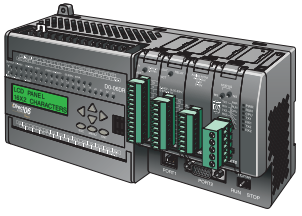
Introduction

Built-in Motion Control Solution



Many machine control applications require various types of simple high-speed monitoring and control. These applications usually involve some type of motion control, or high-speed interrupts for time-critical events. The DL06 Micro PLC solves this traditionally expensive problem with built-in CPU enhancements. Let's take a closer look at the available high-speed I/O features.

The available **high-speed input features** are:

- High Speed Counter (7 kHz max.) with up to 24 counter presets and built-in interrupt subroutine, counts up only, with reset
- Quadrature encoder inputs to measure counts and clockwise or counter-clockwise direction (7 kHz max.), counts up or down, with reset
- High-speed interrupt inputs for immediate response to critical or time-sensitive tasks
- Pulse catch feature to monitor one input point, having a pulse width as small as 100µs (0.1ms)
- Programmable discrete filtering (both on and off delay up to 99ms) to ensure input signal integrity (this is the default mode for inputs X0–X3)

The available **pulse output features** are:

- Single-axis programmable pulse output (10 kHz max.) with three profile types, including trapezoidal moves, registration, and velocity control

Availability of HSIO Features

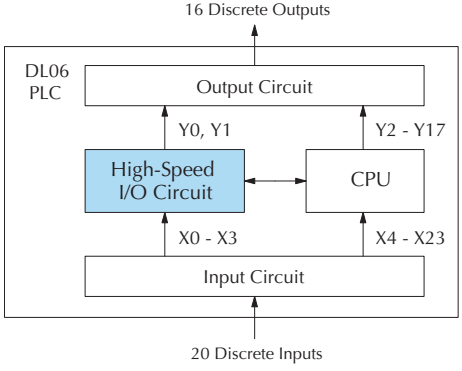
IMPORTANT: Please note the following restrictions on availability of features:

- High-speed input options are available only on DL06s with DC inputs.
- Pulse output options are available only on DL06s with DC outputs.
- Only one HSIO feature may be in use at one time. You cannot use a high–speed input feature and the pulse output at the same time.

Specifications				
DL06 Part Number	**Discrete Input Type**	**Discrete Output Type**	**High-Speed Input**	**Pulse Output**
D0–06AA	AC	AC	No	No
D0–06AR	AC	Relay	No	No
D0–06DA	DC	AC	Yes	No
D0–06DD1	DC	DC	Yes	Yes
D0–06DD2	DC	DC	Yes	Yes
D0–06DR	DC	Relay	Yes	No
D0–06DD1–D	DC	DC	Yes	Yes
D0–06DD2–D	DC	DC	Yes	Yes
D0–06DR–D	DC	Relay	Yes	No

Dedicated High- Speed I/O Circuit

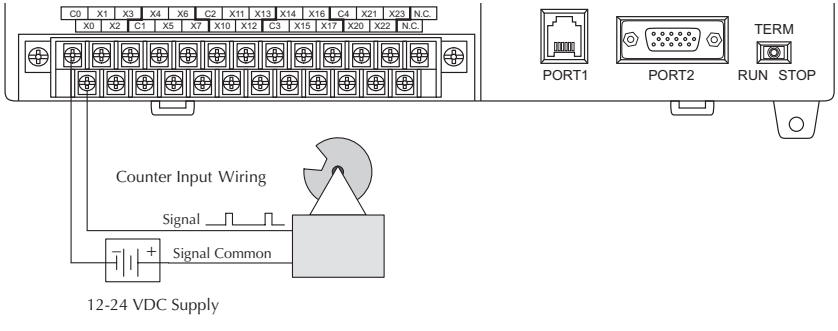
The internal CPU's main task is to execute the ladder program and read/write all I/O points during each scan. In order to service high-speed I/O events, the DL06 includes a special circuit which is dedicated to a portion of the I/O points. Refer to the DL06 block diagram in the figure below.



The high-speed I/O circuit (HSIO) is dedicated to the first four inputs (X0 – X3) and the first two outputs (Y0 – Y1). We might think of this as a *CPU helper*. In the default operation (called "Mode 60") the HSIO circuit just passes through the I/O signals to or from the CPU, so that all twenty inputs behave equally and all sixteen outputs behave equally. When the CPU is configured in any other HSIO Mode, the HSIO circuit imposes a specialized function on the portion of inputs and outputs shown. The HSIO circuit *operates independently of the CPU program scan*. This provides accurate measurement and capturing of high-speed I/O activity while the CPU is busy with ladder program execution.

Wiring Diagrams for Each HSIO Mode

After choosing the appropriate HSIO mode for your application, you'll need to refer to the section in this appendix for that specific mode. Each section includes wiring diagrams to help you connect the High-Speed I/O points correctly to field devices. An example of a High Speed Counter mode diagram is shown below.


C0 X1 X3 X4 X6 C2 X11 X13 X14 X16 C4 X21 X23 N.C.
X0 X2 C1 X5 X7 X10 X12 C3 X15 X17 X20 X22 N.C.
PORT1
PORT2
TERM
RUN STOP
Counter Input Wiring
Signal
Signal Common
12-24 VDC Supply

Choosing the HSIO Operating Mode

Understanding the Six Modes

The High-Speed I/O circuit operates in one of 6 basic modes as listed in the table below. The number in the left column is the mode number (later, we'll use these numbers to configure the PLC). Choose one of the following modes according to the primary function you want from the dedicated High-Speed I/O circuit. You can simply use all twenty inputs and sixteen outputs as regular I/O points with Mode 60.

High Speed I/O Basic Modes		
Mode		**Mode Features**
10	High-Speed Counter	Two 7 kHz counters with 24 presets and reset input, counts up only, cause interrupt on preset
20	Up/Down Counter	7 kHz up/down counter with 24 presets and reset, causes interrupt on preset
		Channel A / Channel B 7 kHz quadrature input, counts up and down
30	Pulse Output	Stepper control – pulse and direction signals, programmable motion profile (10 kHz max.)
40	High-Speed Interrupt	Generates an interrupt based on input transition or time
50	Pulse Catch	Captures narrow pulses on a selected input
60	Filtered Input	Rejects narrow pulses on selected inputs

In choosing one of the six high-speed I/O modes, the I/O points listed in the table below operate only as the function listed. If an input point is not specifically used to support a particular mode, it usually operates as a filtered input by default. Similarly, output points operate normally unless Pulse Output mode is selected.

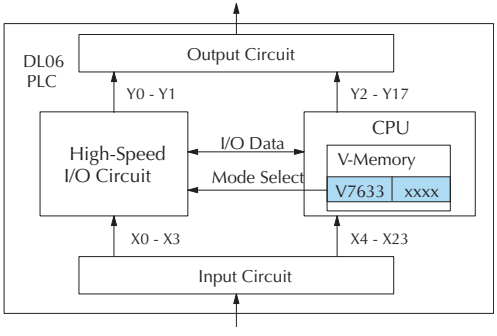
Physical I/O Point Usage							
Mode		DC Input Points				DC Output Points	
		X0	X1	X2	X3	Y0	Y1
10	High-Speed Counter	Counter #1	Counter #2, Interrupt, Pulse Input or Filtered Input	Reset #1, Interrupt, Pulse Input or Filtered Input	Reset #2, Interrupt, Pulse Input or Filtered Input	Regular Output	Regular Output
20	Up/Down counter (Standard counting)	Up Counting	Down Counting	Reset, Pulse Input or Filtered Input	Pulse Input or Filtered Input	Regular Output	Regular Output
	Up/Down counter (Quadrature counting)	Phase A Input	Phase B Input				
30	Pulse Output	Pulse Input or Filtered Input	Pulse Input or Filtered Input	Pulse Input or Filtered Input	Pulse Input or Filtered Input	Pulse or CW Pulse	Direction or CCW Pulse
40	High-Speed Interrupt	Interrupt	Interrupt, Pulse Input or Filtered Input	Interrupt, Pulse Input or Filtered Input	Interrupt, Pulse Input or Filtered Input	Regular Output	Regular Output
50	Pulse Catch	Pulse Input	Pulse Input, Interrupt or Filtered Input	Pulse Input, Interrupt or Filtered Input	Pulse Input, Interrupt or Filtered Input	Regular Output	Regular Output
60	Filtered Input	Filtered Input	Filtered Input	Filtered Input	Filtered Input	Regular Output	Regular Output

Default Mode

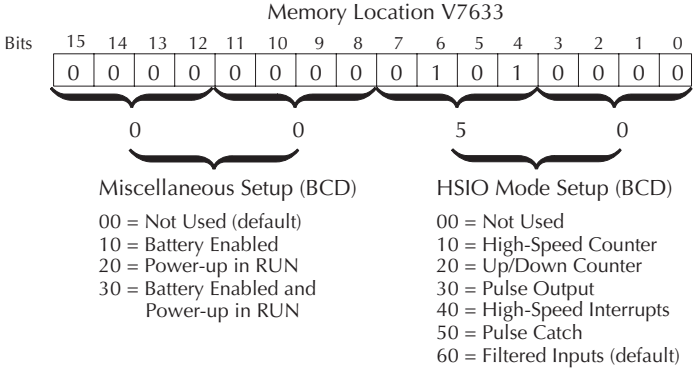
Mode 60 (Filtered Inputs) is the default mode. The DL06 is initialized to this mode at the factory, and any time you initialize the scratchpad memory. In the default condition, X0–X3 are filtered inputs (10 ms delay) and Y0–Y1 are standard outputs.

Configuring the HSIO Mode

If you have chosen a mode suited to the high-speed I/O needs of your application, we're ready to proceed to configure the PLC to operate accordingly. In the block diagram below, notice the V-memory detail in the expanded CPU block. V-memory location V7633 determines the functional mode of the high-speed I/O circuit. *This is the most important V-memory configuration value for HSIO functions!*



The contents of V7633 is a 16-bit word, to be entered in binary–coded decimal. The figure below defines what each 4-bit BCD digit of the word represents.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0
5 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
00 = Not Used
10 = High-Speed Counter
20 = Up/Down Counter
30 = Pulse Output
40 = High-Speed Interrupts
50 = Pulse Catch
60 = Filtered Inputs (default)

Bits 0 – 7 define the mode number 00, 10.. 60 previously referenced in this appendix. The example data "0050" shown selects Mode 50 – Pulse Catch (BCD = 50).

Configuring Inputs X0 – X3

In addition to configuring V7633 for the HSIO mode, you'll need to program the next four locations in certain modes according to the desired function of input points X0 – X3. Other memory locations may require configuring, depending on the HSIO mode (see the corresponding section for particular HSIO modes).

	V-Memory	
Mode	V7633	xxxx
X0	V7634	xxxx
X1	V7635	xxxx
X2	V7636	xxxx
X3	V7637	xxxx

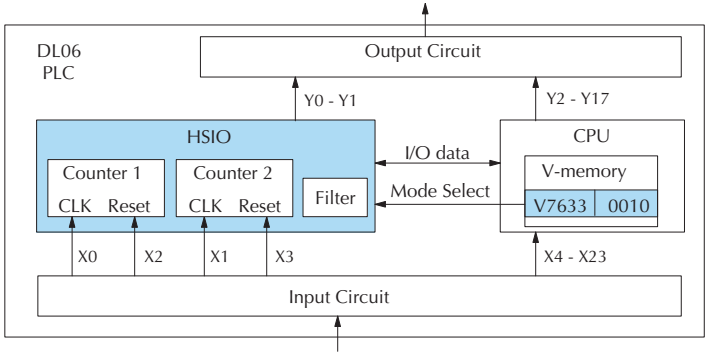
Mode 10: High-Speed Counter

Purpose

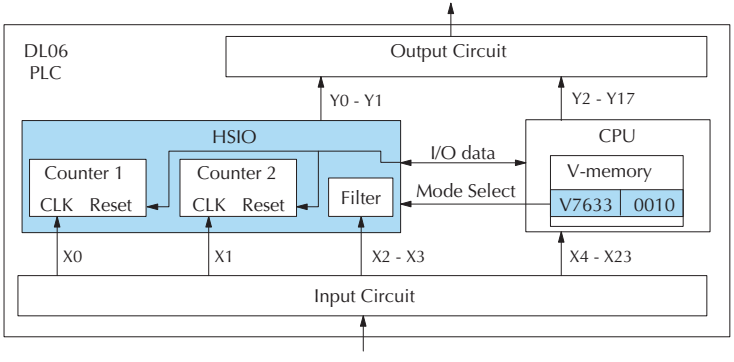
The HSIO circuit contains two high-speed counters. A single pulse train from an external source (X0) clocks the counter on each signal leading edge. The counter counts only upwards, from 0 to 99999999. The counter compares the current count with up to 24 preset values, which you define. The purpose of the presets is to quickly cause an action upon arrival at specific counts, making it ideal for such applications as cut-to-length. It uses counter registers CT174 to CT177 in the CPU.

Functional Block Diagram

Refer to the block diagram below. When the lower byte of HSIO Mode register V7633 contains a BCD "10", the high-speed up counter in the HSIO circuit is enabled. X0 and X1 automatically become the "clock" inputs for the high-speed counters, incrementing them upon each off-to-on transition. The external reset input on X2 and X3 are the default configuration for Mode 10.

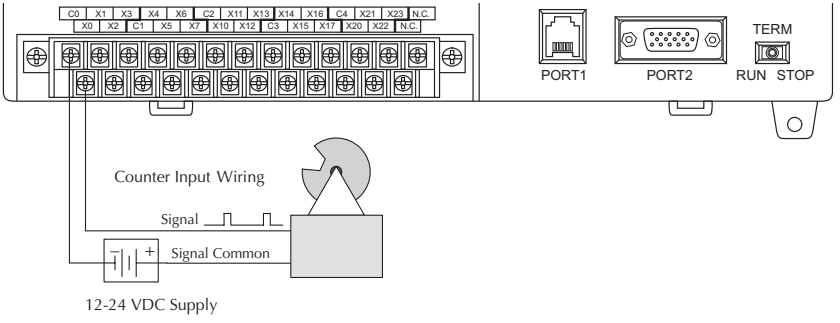


Instead of using X2 and X3 as dedicated reset inputs, you can configure X2 and X3 as normal filtered inputs. In this way, the counter reset must be generated in ladder logic.



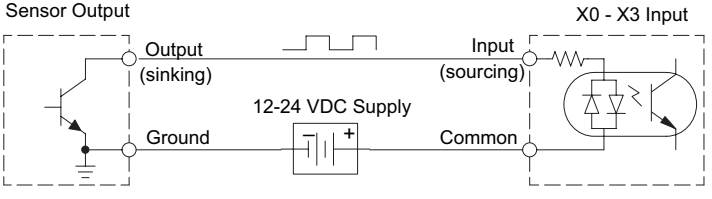
Wiring Diagram

A general wiring diagram for counters/encoders to the DL06 in HSIO Mode 10 is shown below. Many types of pulse-generating devices may be used, such as proximity switches, single-channel encoders, magnetic or optical sensors, etc. Devices with sinking outputs (NPN open collector) are probably the best choice for interfacing. If the counter sources to the inputs, it must output 12 to 24 VDC. Note that devices with 5V sourcing outputs will not work with DL06 inputs.

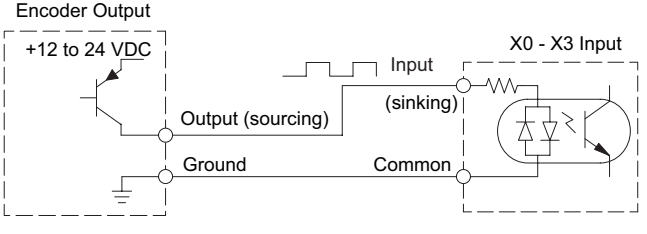

C0 X1 X3 X4 X6 C2 X11 X13 X14 X16 C4 X21 X23 N.C.
X0 X2 C1 X5 X7 X10 X12 C3 X15 X17 X20 X22 N.C.
PORT1
PORT2
TERM
RUN STOP
Counter Input Wiring
Signal
Signal Common
12-24 VDC Supply

Interfacing to Counter Inputs

The DL06's DC inputs are flexible in that they detect current flow in either direction, so they can be wired to a sensor with either sourcing or sinking outputs. In the following circuit, a sensor has an open-collector NPN transistor output. It sinks current from the PLC input point, which sources current. The power supply can be the FA–24PS or another supply (+12VDC or +24VDC), as long as the input specifications are met.

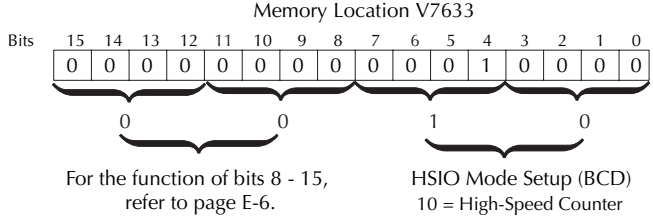


In the circuit diagram below, an encoder has open-emitter PNP transistor outputs. It sources current to the PLC input point, which sinks the current back to ground. Since the encoder sources current, no additional power supply is required. However, note that the encoder output must be 12 to 24 volts (5V encoder outputs will not work).



Setup for Mode 10

V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 10 in the lower byte of V7633 to select the High-Speed Counter Mode.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
0 0
1 0
For the function of bits 8 - 15, refer to page E-6.
HSIO Mode Setup (BCD)
10 = High-Speed Counter

Choose the most convenient method of programming V7633 from the following:

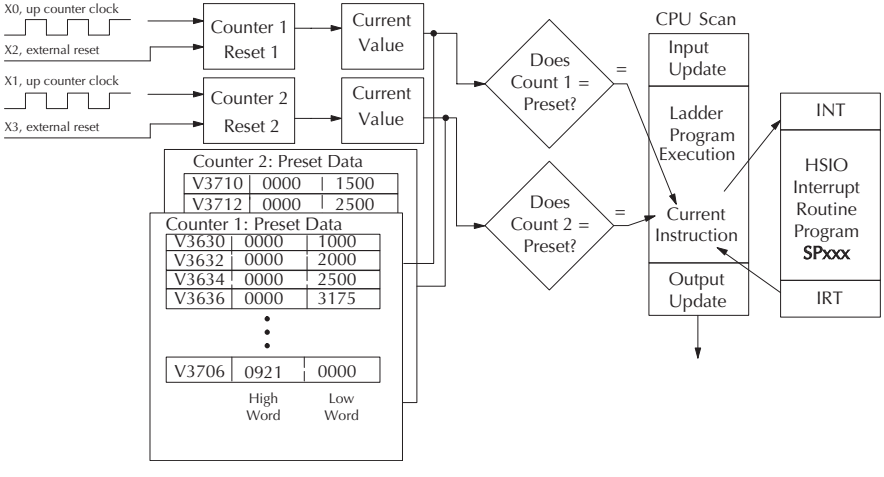
- Include load and out instructions in your ladder program
- ***Direct***SOFT's memory editor or Data View
- Use the Handheld Programmer D2–HPP

We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.

Presets and Special Relays

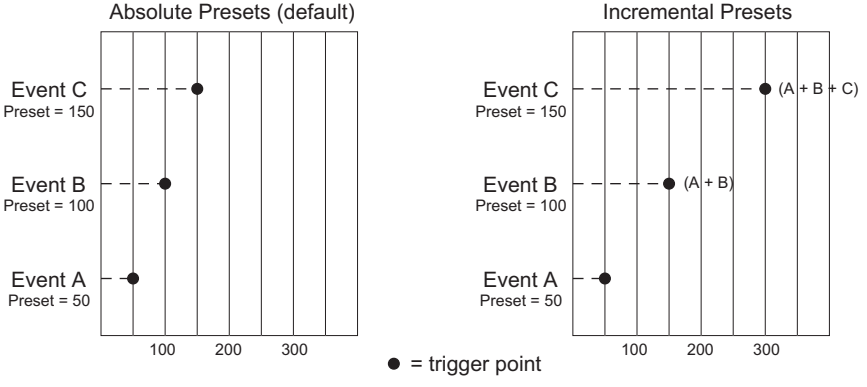
Presets are used to cause a particular action to occur when the count reaches the preset value. Refer to the figure below. Each counter features 24 presets, which you can program. Presets are double word numbers so they occupy two V-memory registers. The user selects the preset values, and the counter continuously compares the current count with the preset. When the two are equal, a special relay contact is energized and program execution jumps to the interrupt routine.

We recommend using the special relay(s) in the interrupt service routine to cause any immediate action you desire. After the interrupt service routine is complete, the CPU returns to the ladder program, resuming program execution from the point of interruption. The compare function is ready for the next preset event.



Absolute and Incremental Presets

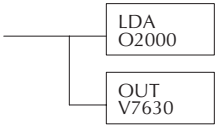
Two preset modes are available, absolute and incremental. Presets are entered into a contiguous block of V-memory registers. In the absolute mode, each preset is treated as the total count. In the incremental mode, the presets are cumulative. Incremental presets represent the number of counts between events.



In the example above, presets are established at 50, 100, and 150. The difference between absolute and incremental modes is shown. Absolute presets trigger events at the preset values, 50, 100, and 150. Incremental presets trigger events at the cumulative totals: 50, 150, and 300.

Preset Data Starting Location

V7630 is the pointer to the V-memory location which contains the beginning of the Preset Data Tables. The default starting location for the Preset Data Tables is V3630 (default after initializing scratchpad). However, you may change this by programming a different value in V7630. Use the LDA and OUT instructions as shown:



Load the octal address, convert to hex, leave result in accumulator.

Output this address to V7630, the location of the pointer to the Preset data.

Preset Table Pointer

V7630	2000

Preset Table

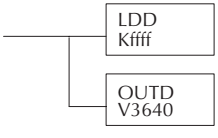
V2001	V2000	0000	1000
V2003	V2002	0000	2000
V2005	V2004	0000	2500
V2007	V2006	0000	3175
V2077	V2076	0000	0000

Using Fewer than 24 Presets

When all 24 available presets are used, the CPU knows automatically when it reaches the end of the preset table. When using fewer than 24 presets, however, it is necessary to signal the CPU that it has reached the last preset. The way to signal the end of the block of presets is to insert one of the following **table-end** codes into the next available register pair:

Table-end Code	Applicable Mode	Meaning
0000 FFFF	Absolute and Incremental	Signals end of presets
0000 00FF	Incremental	Signals end of presets and restarts presets. Does not reset accumulated pulse counts of CT174 or CT176.
0000 FF00	Incremental	Signals end of presets, restarts presets and resets accumulated pulse counts of CT174 or CT176.

As shown in the table above, each of the **table-end** signals has a different meaning. Use the LDD Kffff instruction to insert the table-end code into the next register pair beyond the preset table. In the example, four presets are used. The 0000 FFFF in V3641-V3640 indicates the previous preset was the last preset.



Load 0000 FFFF into accumulator.

Output this value to V3640/V3641, the registers beyond the Preset Table.

Default Preset Table Example

V3631	V3630	0000	1000
V3633	V3632	0000	2000
V3635	V3634	0000	2500
V3637	V3636	0000	3175
V3641	V3640	0000	FFFF

In incremental mode, you can choose not to reset the counter or the cumulative total, or you can choose to reset only the counter, or you can choose to reset the counter and the cumulative total when the table-end code is read. In the example, FFFF has been placed in V3640 since the last preset was in V3636, and we are using fewer than 24 presets.

NOTE: *In absolute mode each successive preset must be greater than the previous preset value. If a preset value is less than a lower-numbered preset value, the CPU cannot compare to that value, since the counter can only count upwards.*

Equal Relay Numbers

The following table lists all 24 preset register default locations for each high-speed counter. Each occupies two 16-bit V-memory registers. The corresponding special relay contact number is in the next column. We might also call these *equal* relay contacts, because they are true (closed) when the present high-speed counter value is equal to the preset value. Each contact remains closed until the counter value equals the next preset value.

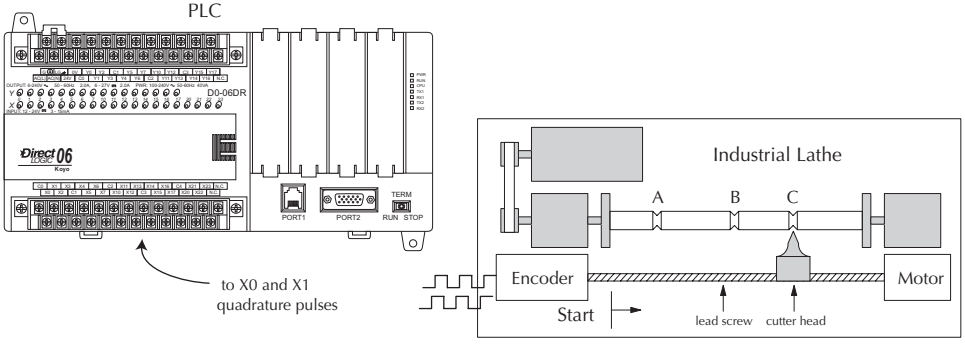
Preset Register Table					
Counter 1 Preset	Preset V-memory Register	Special Relay Number	Counter 2 Preset	Preset V-memory Register	Special Relay Number
1	V3631 / V3630	SP540	1	V3711 / V3710	SP570
2	V3633 / V3632	SP541	2	V3713 / V3712	SP571
3	V3635 / V3634	SP542	3	V3715 / V3714	SP572
4	V3637 / V3636	SP543	4	V3717 / V3716	SP573
5	V3641 / V3640	SP544	5	V3721 / V3720	SP574
6	V3643 / V3642	SP545	6	V3723 / V3722	SP575
7	V3645 / V3644	SP546	7	V3725 / V3724	SP576
8	V3647 / V3646	SP547	8	V3727 / V3726	SP577
9	V3651 / V3650	SP550	9	V3731 / V3730	SP600
10	V3653 / V3652	SP551	10	V3733 / V3732	SP601
11	V3655 / V3654	SP552	11	V3735 / V3734	SP602
12	V3657 / V3656	SP553	12	V3737 / V3736	SP603
13	V3661 / V3660	SP554	13	V3741 / V3740	SP604
14	V3663 / V3662	SP555	14	V3743 / V3742	SP605
15	V3665 / V3664	SP556	15	V3745 / V3744	SP606
16	V3667 / V3666	SP557	16	V3747 / V3746	SP607
17	V3671 / V3670	SP560	17	V3751 / V3750	SP610
18	V3673 / V3672	SP561	18	V3753 / V3752	SP611
19	V3675 / V3674	SP562	19	V3755 / V3754	SP612
20	V3677 / V3676	SP563	20	V3757 / V3756	SP613
21	V3701 / V3700	SP564	21	V3761 / V3760	SP614
22	V3703 / V3702	SP565	22	V3763 / V3762	SP615
23	V3705 / V3704	SP566	23	V3765 / V3764	SP616
24	V3707 / V3706	SP567	24	V3767 / V3766	SP617

The consecutive addresses shown above for each relay are those assigned by the CPU as default addresses. The Pointer for the start of these addresses is stored by the CPU at V7630. If you have a conflict of addresses because of pre-existing code written to these addresses, you can change the default block of addresses merely by having your ladder logic place a different pointer value in V7630. To change the table location. use the LDA and OUT instructions as shown on the previous page.

Calculating Your Preset Values

The preset values occupy two data words each. They can range in value from -8388608 to 8388607, just like the high-speed counter value. All 24 values are absolute values, meaning that each one is an offset from the counter zero value.

The preset values must be individually derived for each application. In the industrial lathe diagram below, the PLC monitors the position of the lead screw by counting pulses. At points A, B, and C along the linear travel, the cutter head pushes into the work material and cuts a groove.



The timing diagram below shows the duration of each equal relay contact closure. Each contact remains on until the next one closes. All go off when the counter resets.

NOTE: *Each successive preset must be two numbers greater than the previous preset value. In the industrial lathe example, B>A+2 and C>B+2.*

X Input Configuration

The configurable discrete input options for High-Speed Counter Mode are listed in the table below. Input X0 is dedicated for the first counter clock input. Input X1 can be the clock for the second counter or a filtered input. The section on Mode 60 operation at the end of this appendix describes programming the filter time constants. Inputs X2 and X3 can be configured as the counter resets, with or without the interrupt option. The interrupt option allows the reset input (X2 and X3) to cause an interrupt like presets do, but there is no SP relay contact closure (instead, X2 and X3 will be on during the interrupt routine, for 1 scan). Or finally, X2 and X3 may be left simply as a filtered input.

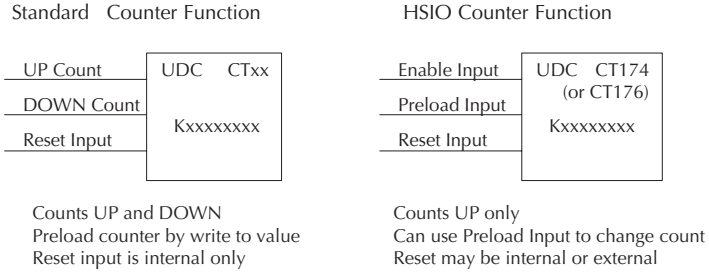
Input Options			
Input	**Configuration Register**	**Function**	**Hex Code Required**
X0	V7634	Counter #1 Clock	0001 (absolute) (default)
			0101 (incremental)
X1	V7635	Counter #2 Clock	0001 (absolute) (default)
			0101 (incremental)
		Interrupt	0004
		Pulse Input	0005
		Filtered Input	xx06, xx = filter time 0 - 99 ms (BCD)
X2	V7636	Counter #1 Reset (no interrupt)	0007* (default) 0207*
		Counter #1 Reset (with interrupt)	0107* 0307*
		Interrupt	0004
		Pulse Input	0005
		Filtered Input	xx06, xx= filter time 0 - 99 ms (BCD)
X3	V7637	Counter #2 Reset (no interrupt)	0007* (default) 0207*
		Counter #2 Reset (with interrupt)	0107* 0307*
		Interrupt	0004
		Pulse Input	0005
		Filtered Input	xx06, xx= filter time 0 - 99 ms (BCD)

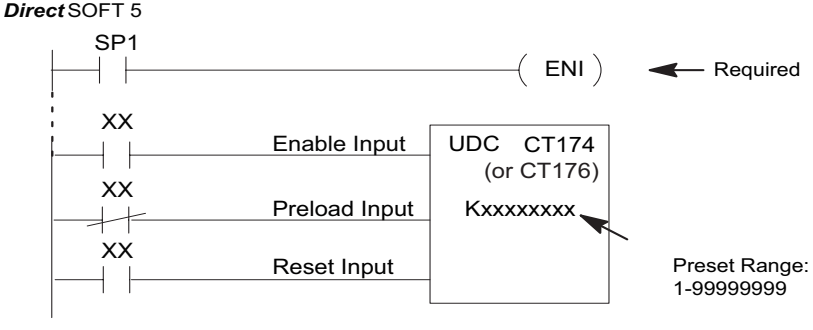
*With the counter reset, you have the option of a normal reset or a faster reset. However, the fast reset does not recognize changed preset values during program execution. When '0007' or '0107' are set in V7636 or V7637 and preset values are changed during program execution, the DL06 recognizes the changed preset values at the time of the reset. When '0207' or '0307' are set in V7636 or V7637, the CPU does not check for changed preset values, so the DL06 has a faster reset time.

Writing Your Control Program

The mnemonic for the counter instruction is UDC (up-down counter).The DL06 can have up to 128 counters, labeled CT0 through CT177. The high speed counter in the HSIO circuit is accessed in ladder logic by using UDC CT174 and CT176. It uses counter registers CT174 through CT177 exclusively when the HSIO mode 10 is active (otherwise, CT174 through CT177 are available for standard counter use). The HSIO counter needs two registers because it is a double-word counter. It has three inputs as shown. The first input (Enable) allows counting when active. The middle input is used to preload the counter value. The bottom signal is the reset. The Preload Input must be off while the counter is counting.

The next figure shows how the HSIO counter will appear in a ladder program. Note that the Enable Interrupt (ENI) command must execute before the counter value reaches the first preset value. We do this at powerup by using the first scan relay. When using the counter but not the presets and interrupt, we can omit the ENI.

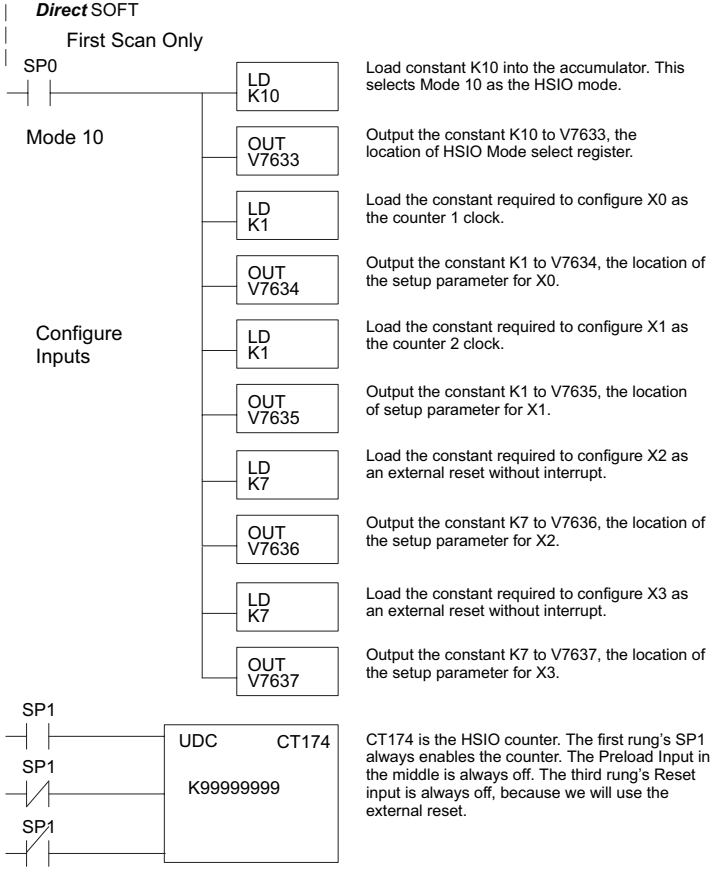




When the enable input is energized, the up/down counter CT174 will respond to pulses on X0 and increment. The up/down counter CT176 will respond to pulses on X1 and increment. The reset input contact behaves in a logical OR fashion with the physical reset input. X2 (when selected) resets counter 1. X3 (when selected) resets counter 2. So, the high speed counter can receive a reset from either the contact(s) on the reset rung in the ladder, OR the external reset X2 or X3, if you have configured X2 or X3 as an external reset.

Program Example 1: Counter Without Presets

The following example is the simplest way to use the high-speed counters, which does not use the presets and special relays in the interrupt routine. The program configures the HSIO circuit for Mode 10 operation, so X0 is automatically the counter clock input for the first counter, and X1 is the counter clock input for the second counter. It uses the Compare-double (CMPD) instruction to cause action at certain count values. Note that this allows you to have more than 24 presets. Then, it configures X2 and X3 to be the external reset of the counter.


Direct SOFT
First Scan Only
SP0
Mode 10
Configure Inputs
LD K10
Load constant K10 into the accumulator. This selects Mode 10 as the HSIO mode.
OUT V7633
Output the constant K10 to V7633, the location of HSIO Mode select register.
LD K1
Load the constant required to configure X0 as the counter 1 clock.
OUT V7634
Output the constant K1 to V7634, the location of the setup parameter for X0.
LD K1
Load the constant required to configure X1 as the counter 2 clock.
OUT V7635
Output the constant K1 to V7635, the location of setup parameter for X1.
LD K7
Load the constant required to configure X2 as an external reset without interrupt.
OUT V7636
Output the constant K7 to V7636, the location of the setup parameter for X2.
LD K7
Load the constant required to configure X3 as an external reset without interrupt.
OUT V7637
Output the constant K7 to V7637, the location of the setup parameter for X3.
SP1
SP1
SP1
UDC CT174
K99999999
CT174 is the HSIO counter. The first rung's SP1 always enables the counter. The Preload Input in the middle is always off. The third rung's Reset input is always off, because we will use the external reset.

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Program Example: (cont'd)

The compare double instructions below use the current count of the HSIO counter to turn on Y0 and Y1. This technique can make more than 24 comparisons, but it is scan-time dependent. However, use the 24 built-in presets with the interrupt routine if your application needs a very fast response time, as shown in the next example.

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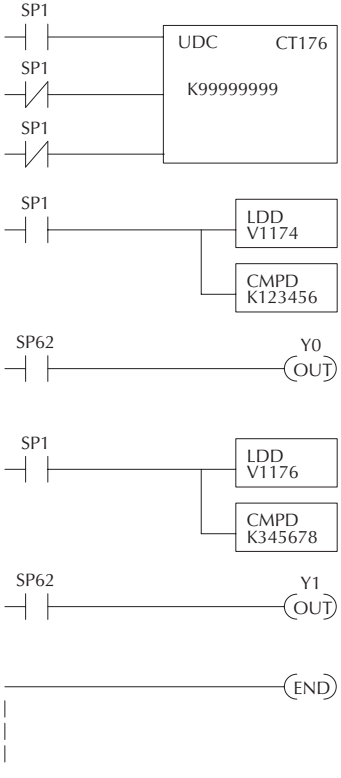


CT176 always enables the counter. The Preload Input in the middle is always of f. The third rung's Reset input is always off, because we will use the external reset.

Load the current count of the HSIO counter in V1174 and V1175 into the accumulator

Use the Compare-double instruction to compare the double word in the accumulator to the constant K123456.

The execution of the above CMPD instruction turns on special relay contact SP62 if the current count is greater than the comparison number (K123456).

Load the current count of the HSIO counter in V1176 and V1177 into the accumulator

Use the Compare-double instruction to compare the double word in the accumulator to the constant K345678

The execution of the above CMPD instruction turns on special relay contact SP62 if the current count is greater than the comparison number (K345678).

END coil marks the end of the main program.

Program Example 2: Counter With Presets

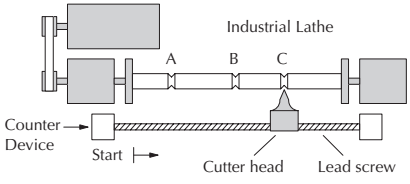
The following example shows how to program the HSIO circuit to trigger on three preset values. You may recall the industrial lathe example from the beginning of this appendix. This example program shows how to control the lathe cutter head to make three grooves in the work-piece at precise positions. When the lead screw turns, the counter device generates pulses which the DL06 can count. The three preset variables A, B, and C represent the positions (number of pulses) corresponding to each of the three grooves. In this example, only one high-speed counter is used. The second counter could be used in the same manner.

Preset Data

A	V3630	0000	1500
B	V3632	0000	3780
C	V3634	0000	4850
	V3636	0000	FFFF

I/O Assignments

X3 - Cutter head extended
X4 - Cutter head retracted
Y0 - Lead screw motor
Y1 - Cutter head solenoid



***Direct*SOFT**

SP0	ENI	Enable Interrupts before reaching a preset generates an interrupt. Special Relay SP0 is on during the first CPU scan.
SP0	LD K10	Load constant K10 into the accumulator. This selects Mode 10 as the HSIO mode.
	OUT V7633	Output the constant to V7633, the location of HSIO Mode select register.
	LD K1	Load the constant required to configure X0 as the counter clock.
	OUT V7634	Output the constant K1 to V7634, the location of the setup parameter for X0.
Select Mode 10	LD K1006	Load the constant required to configure X1 as a filtered input.
	OUT V7635	Output the constant to V7635, the location of the setup parameter for X1.
	LD K107	Load the constant required to configure X2 as an external reset with interrupt.
	OUT V7636	Output the constant to V7636, the location of the setup parameter for X2.
	LD K1006	Load the constant required to configure X3 as a filtered input.
	OUT V7637	Output the constant to V7637, the location of the setup parameter for X3.
	LDA O3630	Load the octal address O3630 into the accumulator. This instruction automatically converts the address into hex.
	OUT V7630	Output this address to V7630, the location of the pointer to the Preset Table.

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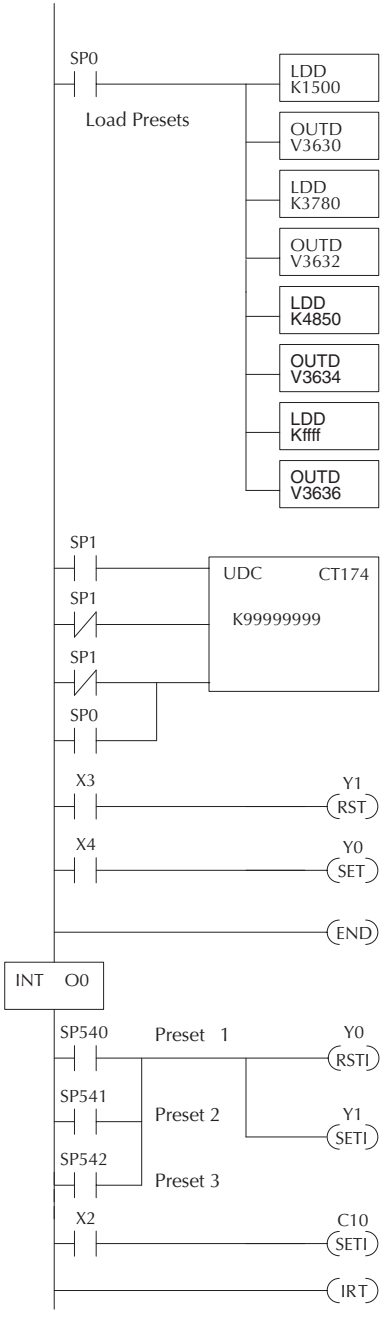


Load the preset A value into the accumulator .

Output the accumulator contents to the memory location for preset 1.

Load the preset B value into the accumulator .

Output the accumulator contents to the memory location for preset 2.

Load the preset C value into the accumulator .

Output the accumulator contents to the memory location for preset 3.

Load the constant Kffff into the accumulator. This value represents the end of the preset list.

Output the accumulator contents to the memory location for preset 4 (end of preset marker).

CT174 is the HSIO counter. The first rung's SP1 always enables the counter. The preload input in the middle is off (unused in this example).

The third rung's Reset input is normally off, because we will use the external reset. You can optionally reset the counter value on each powerup using the SP0 contact.

Input X3 energizes when the groove has finished cutting. So, we retract the cutter head.

Turn lead screw on again, after cutter head has retracted.

END coil marks the end of the main program.

The INT label marks the beginning of the interrupt service routine program.

Inside the interrupt service routine, we turn OFF the lead screw motor immediately.

These special "equal" relays turn on individually as the corresponding preset is reached. In this application, each results in the cutting of a groove (Y1), so they are logically ORed together .

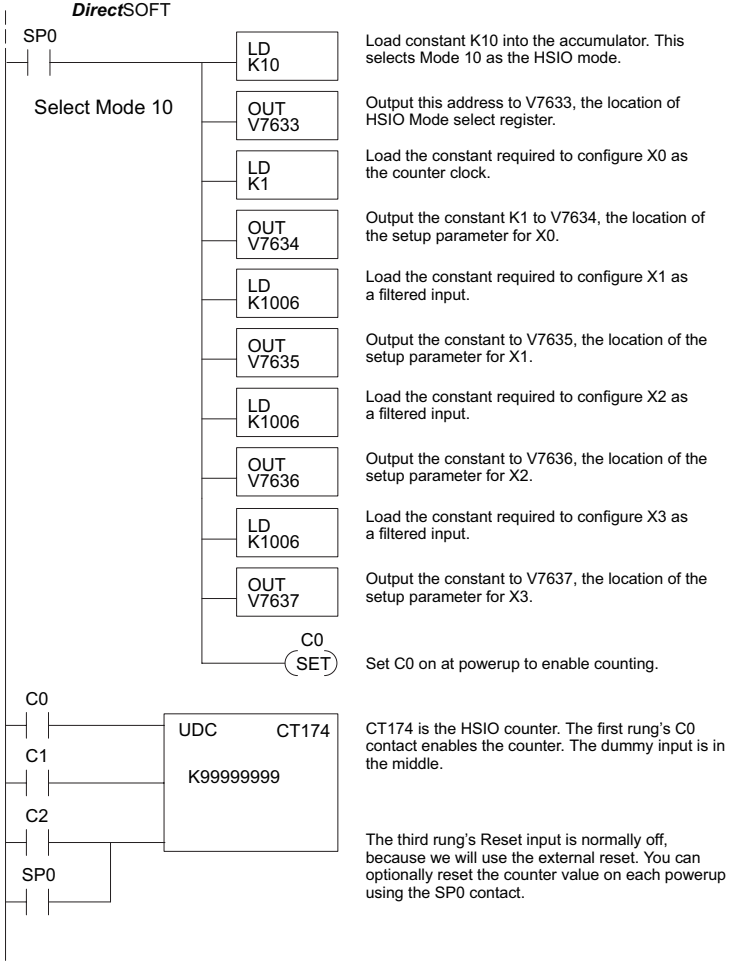
Input X2 will be energized inside the interrupt routine if X2 external interrupt was the source.

Return from the interrupt service routine.

Some applications will require a different type of action at each preset. It is possible for the interrupt routine to distinguish one preset event from another, by turning on a unique output for each equal relay contact SPxxx. We can determine the source of the interrupt by examining the equal relay contacts individually, as well as X2. The X2 contact will be on (inside the interrupt routine only) if the interrupt was caused by the external reset, X2 input.

Program Example 3: Counter With Preload

The following example shows how you can preload the current count with another value. When the preload command input (X4 in this example) is energized, we disable the counter from counting with C0. Then, we write the value K3000 to the count register (V1076-V1077). We preload the current count of the counter with K3000. When the preload command (X4) is turned off, the counter resumes counting any pulses, but now starting from K3000. In this example, only one high-speed counter is used. The second counter could be used in the same manner.


DirectSOFT
SP0
Select Mode 10
LD K10
Load constant K10 into the accumulator. This selects Mode 10 as the HSIO mode.
OUT V7633
Output this address to V7633, the location of HSIO Mode select register.
LD K1
Load the constant required to configure X0 as the counter clock.
OUT V7634
Output the constant K1 to V7634, the location of the setup parameter for X0.
LD K1006
Load the constant required to configure X1 as a filtered input.
OUT V7635
Output the constant to V7635, the location of the setup parameter for X1.
LD K1006
Load the constant required to configure X2 as a filtered input.
OUT V7636
Output the constant to V7636, the location of the setup parameter for X2.
LD K1006
Load the constant required to configure X3 as a filtered input.
OUT V7637
Output the constant to V7637, the location of the setup parameter for X3.
C0
SET
Set C0 on at powerup to enable counting.
C0
C1
C2
SP0
UDC CT174
K99999999
CT174 is the HSIO counter. The first rung's C0 contact enables the counter. The dummy input is in the middle.
The third rung's Reset input is normally off, because we will use the external reset. You can optionally reset the counter value on each powerup using the SP0 contact.

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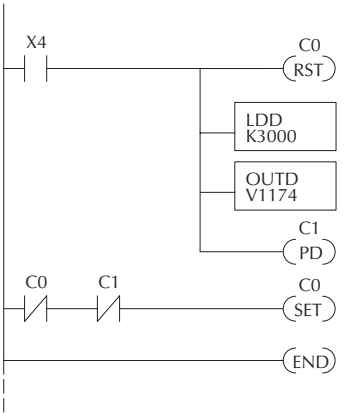


When the preload request is made, the user turns on X4. First we disable counting by resetting C0, the counter's enable input.

Load the BCD value K3000 into the accumulator.

Output the constant to V1174/V1175, the location of the accumulated count for CT76.

Generate a preload counter input pulse, which causes the counter to preload from V1174-V1175.

Enable the counter by setting C0, when the preolad pulse on C1 has occurred (C1 is off).

END coil marks the end of the main program.

Troubleshooting Guide for Mode 10

If you're having trouble with Mode 10 operation, please study the following symptoms and possible causes. The most common problems are listed below.

Symptom: The counter does not count.

Possible causes:

1. **Field sensor and wiring** – Verify that the encoder, proximity switch, or sensor actually turns on and illuminates the status LED for X0 (counter 1) and X1 (counter 2). The problem could be due to sinking-sourcing wiring problem, etc. Remember to check the signal ground connection. Also verify that the pulse on-time is long enough for the PLC to recognize it.
2. **Configuration** – use the Data View window to check the configuration parameters. V7633 must be set to 10, and V7634 must be set to 1 or 101 to enable the first high-speed counter. V7635 must be set to 1 or 101 to enable the second high-speed counter.
3. **Stuck in reset** – check the input status of the reset input, X2 and X3. If X2 is on, the counter will not count because it is being held in reset.
4. **Ladder program** – make sure you are using counter CT174 and CT176 in your program. The top input is the enable signal for the counter. It must be on before the counter will count. The middle input is the dummy input. The bottom input is the counter reset, and must be off during counting.

Symptom: The counter counts but the presets do not function.

Possible causes:

1. **Configuration** – Ensure the preset values are correct. The presets are 32-bit BCD values having a range of 0 to 99999999. Make sure you write all 32 bits to the reserved locations by using the LDD and OUTD instructions. Use only even–numbered addresses, from V3630 to V3767. If using less than 24 presets, be sure to place "0000FFFF," "0000FF00," or "000000FF" in the location after the last preset used.
2. **Interrupt routine** – Only use Interrupt #0. Make sure the interrupt has been enabled by executing an ENI instruction prior to needing the interrupt. The interrupt routine must be placed after the main program, using the INT label and ending with an interrupt return IRT.
3. **Special relays** – Check the special relay numbers in your program. Use SP540 for Preset 1, SP541 for Preset 2, etc. Remember that only one special equal relay contact is on at a time. When the counter value reaches the next preset, the SP contact which is on now goes off and the next one turns on.

Symptom: The counter counts up but will not reset.

Possible causes:

1. Check the LED status indicator for X2 (counter 1) and X3 (counter 2) to make sure it is active when you want a reset. Or, if you are using an internal reset, use the status mode of DirectSOFT to monitor the reset input to the counter.

Mode 20: Up/Down Counter

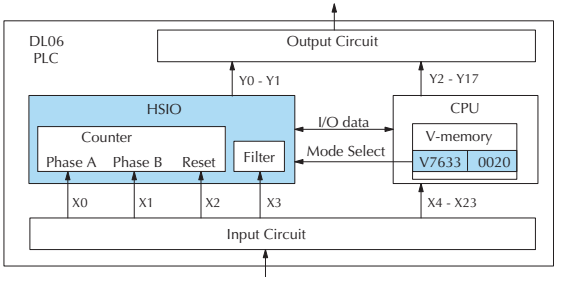
Purpose

The counter in the HSIO circuit can count up/down signals from two separate sources (i.e., two single channel encoders) or two quadrature signal pulses. Quadrature signals are commonly generated from incremental encoders, which may be rotary or linear. The up/down counter has a range from -8388608 to 8388607. Using CT174 and CT175, the quadrature counter can count at up to a 7 kHz rate.

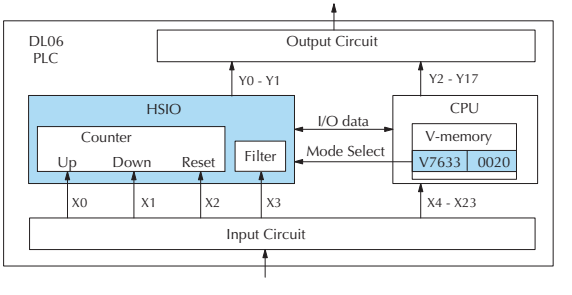
NOTE: *The count is 32 bit BCD sign + magnitude format.*

Functional Block Diagram

The diagram below shows HSIO functionality in Mode 20. When the lower byte of HSIO Mode register V7633 contains a BCD "20", the up/down counter in the HSIO circuit is enabled. For quadrature counting, input X0 is dedicated to the Phase A quadrature signal,



and input X1 receives Phase B signal. X2 is dedicated to reset the counter to zero value when energized.



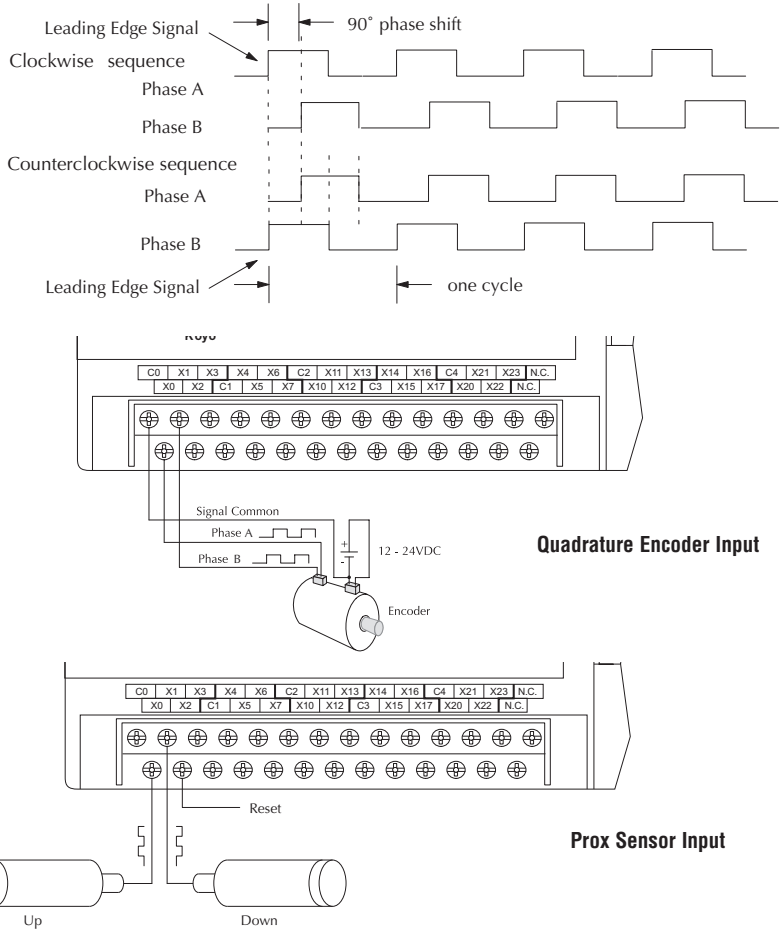
For standard up/down counting, input X0 is dedicated to the up counting signal, and input X1 is dedicated to the down counting signal. The X2 input resets the counter to zero when energized.

Quadrature Encoder Signals

Quadrature encoder signals contain position and direction information, while their frequency represents speed of motion. Phase A and B signals shown below are phase-shifted 90 degrees, thus the quadrature name. When the rising edge of Phase A precedes Phase B's leading edge (indicates clockwise motion by convention), the HSIO counter counts UP. If Phase B's rising edge precedes Phase A's rising edge (indicates counter-clockwise motion), the counter counts DOWN.

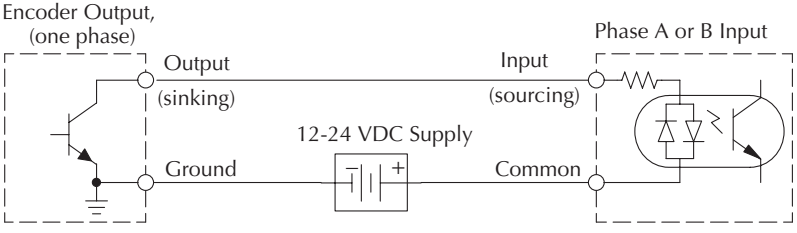
Wiring Diagram

A general wiring diagram for encoders to the DL06 in HSIO Mode 20 is shown below. Encoders with sinking outputs (NPN open collector) are probably the best choice for interfacing. If the encoder sources to the inputs, it must output 12 to 24 VDC. Note that encoders with 5V sourcing outputs will not work with DL06 inputs.

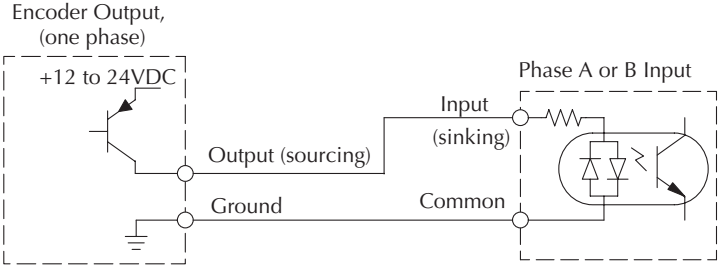


Interfacing to Encoder Outputs

The DL06's DC inputs are flexible in that they detect current flow in either direction, so they can be wired to an encoder with either sourcing or sinking outputs. In the following circuit, an encoder has open-collector NPN transistor outputs. It sinks current from the PLC input point, which sources current. The power supply can be the +24VDC auxiliary supply or another supply (+12VDC or +24VDC), as long as the input specifications are met.

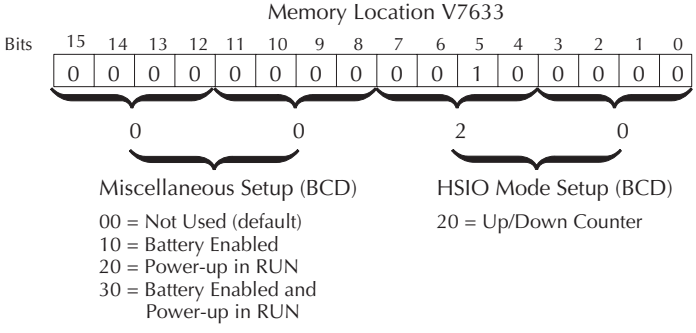


In the next circuit, an encoder has open-emitter PNP transistor outputs. It sources current to the PLC input point, which sinks the current back to ground. Since the encoder sources current, no additional power supply is required. However, note that the encoder output must be 12 to 24 volts (5V encoder outputs will not work).



Setup for Mode 20

Remember that V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 20 in the lower byte of V7633 to select the High-Speed Counter Mode.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0
0 0
2 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
20 = Up/Down Counter

Choose the most convenient method of programming V7633 from the following:

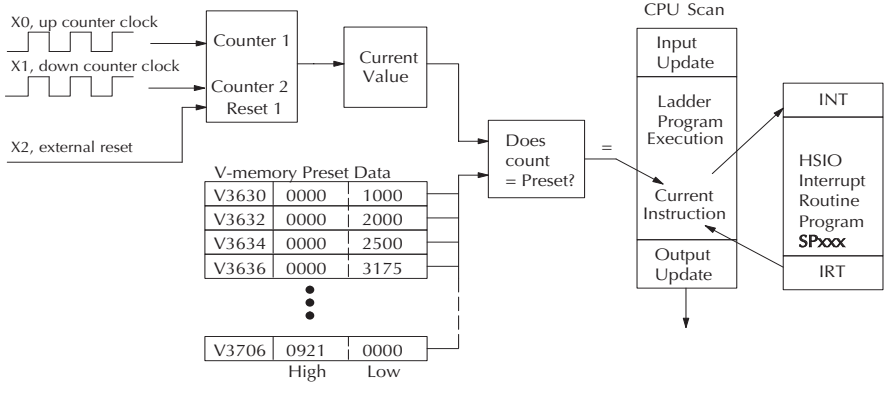
- Include load and out instructions in your ladder program
- *Direct*SOFT's memory editor
- Use the Handheld Programmer D2–HPP

We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.

Presets and Special Relays

The goal of counting is to cause a particular action to occur when the count reaches a preset value. Refer to the figure below. Each counter features 24 presets, which you can program. A preset is a number you select and store so that the counter will continuously compare the current count with the preset. When the two are equal, a special relay contact is energized and program execution jumps to the interrupt routine.

We recommend using the special relay(s) in the interrupt service routine to cause any immediate action you desire. After the interrupt service routine is complete, the CPU returns to the ladder program, resuming program execution from the point of interruption. The compare function is ready for the next preset event.



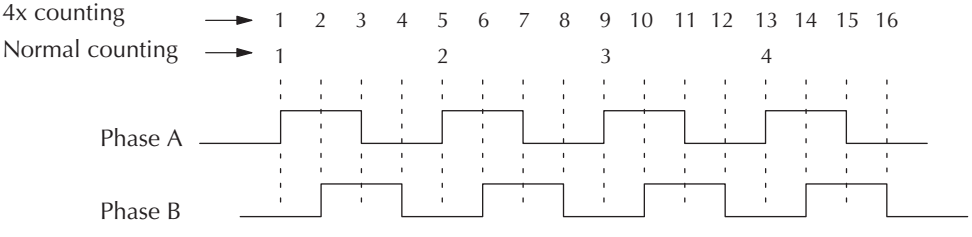
X Input Configuration

The configurable discrete input options for High-Speed Counter Mode are listed in the table below. The section on Mode 60 operation at the end of this appendix describes programming the filter time constants.

Mode 20 Up/Down Counter

Input	Configuration Register	Function	Hex Code Required
X0	V7634	Up counting	0202 (standard, absolute)
			0302 (standard, incremental)
		Phase A	0002 (quadrature, absolute) (default)
			0102 (quadrature, incremental)
			1002 (quadrature, absolute) 4x counting*
			1102 (quadrature, incremental) 4x counting*
X1	V7635	Down counting or Phase B	0000
X2	V7636	Counter Reset (no interrupt)	0007** (default) 0207**
		Counter Reset (with interrupt)	0107** 0307**
		Pulse input	0005
		Filtered input	xx06 (xx = filter time, 0 - 99ms (BCD)
X3	V7637	Pulse input	0005
		Filtered input	xx06 (xx = filter time, 0 - 99ms (BCD) (default)

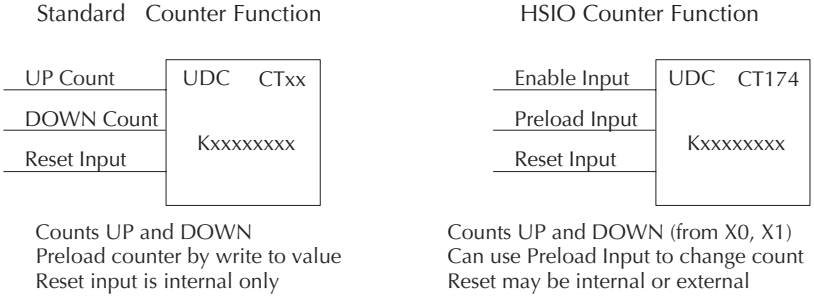
* With this feature, you can count 4 times more with the same encoder.



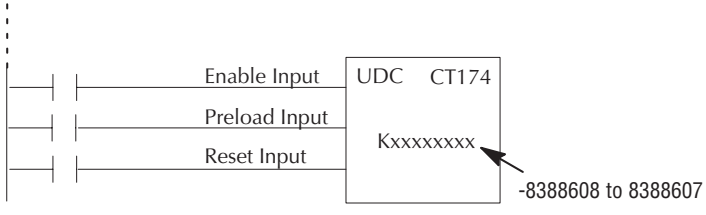
** With the counter reset you have the option of a normal reset or a faster reset. However, the fast reset does not recognize changed preset values during program execution. When '0007' or '0107' are set in V7636 and preset values are changed during program execution, the DL06 recognizes the changed preset values at the time of the reset. When '0207' or '0307' are set in V7636 the CPU does not check for changed preset values, so the DL06 has a faster reset time.

Writing Your Control Program

The mnemonic for the counter is UDC (up-down counter). The DL06 can have up to 128 counters, labeled CT0 through CT177. The quadrature counter in the HSIO circuit is accessed in ladder logic by using UDC CT174. It uses counter registers CT174 and CT175 exclusively when the HSIO mode 20 is active (otherwise, CT174 and CT175 are available for standard counter use). The HSIO counter needs two registers because it is a double-word counter. It has three inputs as shown. The first input is the enable signal, the middle is a preload (write), and the bottom is the reset. The enable input must be on before the counter will count. The enable input must be off during a preload.



The next figure shows the how the HSIO quadrature counter will appear in a ladder program.

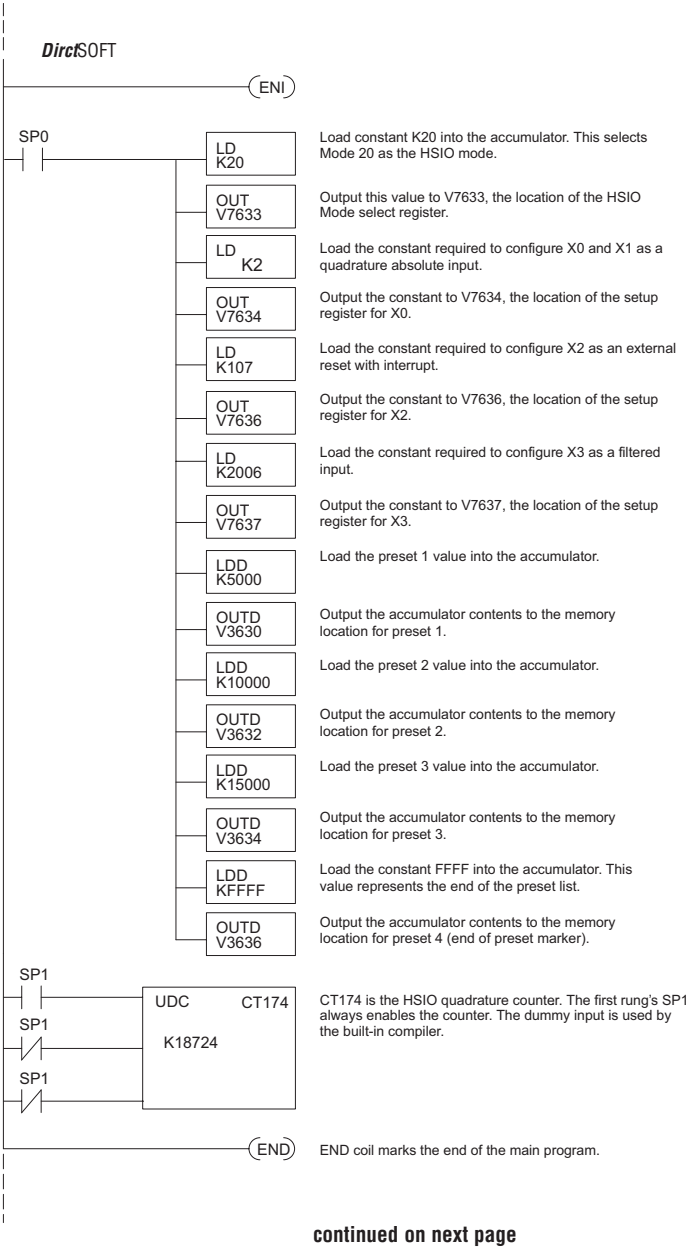


When the enable input is energized, the counter will respond to quadrature pulses on X0 and X1, incrementing or decrementing the counter at CT174 – CT175. The reset input contact behaves in a logical OR fashion with the physical reset input X2. This means the quadrature counter can receive a reset from either the contact(s) on the reset rung in the ladder, OR the external reset X2.

NOTE: *The count is 32 bit BCD sign + magnitude format.*

Program Example 1: Quadrature Counting with an Interrupt

Below is a simple example of how quadrature counting with an interrupt can be programmed.


DirectSOFT
ENI
SP0
LD K20
Load constant K20 into the accumulator. This selects Mode 20 as the HSIO mode.
OUT V7633
Output this value to V7633, the location of the HSIO Mode select register.
LD K2
Load the constant required to configure X0 and X1 as a quadrature absolute input.
OUT V7634
Output the constant to V7634, the location of the setup register for X0.
LD K107
Load the constant required to configure X2 as an external reset with interrupt.
OUT V7636
Output the constant to V7636, the location of the setup register for X2.
LD K2006
Load the constant required to configure X3 as a filtered input.
OUT V7637
Output the constant to V7637, the location of the setup register for X3.
LDD K5000
Load the preset 1 value into the accumulator.
OUTD V3630
Output the accumulator contents to the memory location for preset 1.
LDD K10000
Load the preset 2 value into the accumulator.
OUTD V3632
Output the accumulator contents to the memory location for preset 2.
LDD K15000
Load the preset 3 value into the accumulator.
OUTD V3634
Output the accumulator contents to the memory location for preset 3.
LDD KFFFF
Load the constant FFFF into the accumulator. This value represents the end of the preset list.
OUTD V3636
Output the accumulator contents to the memory location for preset 4 (end of preset marker).
SP1
SP1
SP1
UDC CT174
K18724
CT174 is the HSIO quadrature counter. The first rung's SP1 always enables the counter. The dummy input is used by the built-in compiler.
END
END coil marks the end of the main program.

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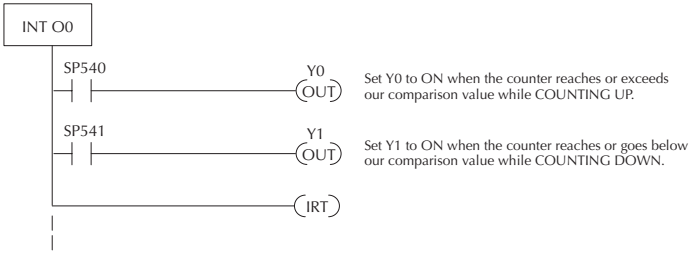

INT O0
SP540
Y0
OUT
Set Y0 to ON when the counter reaches or exceeds our comparison value while COUNTING UP.
SP541
Y1
OUT
Set Y1 to ON when the counter reaches or goes below our comparison value while COUNTING DOWN.
IRT

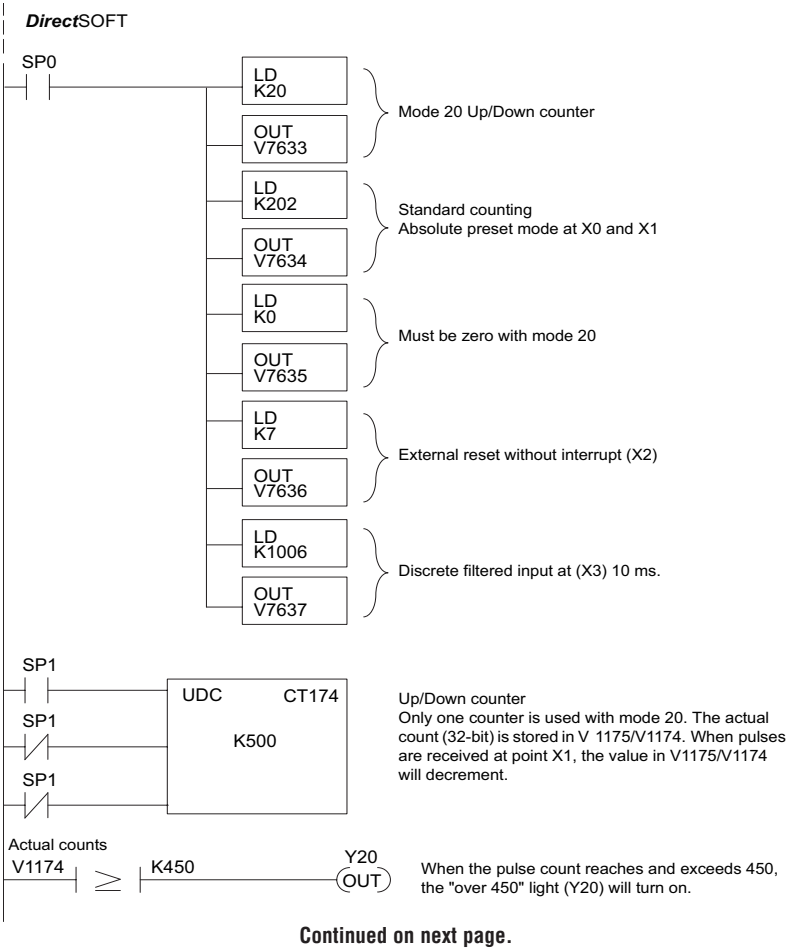
The Load Accumulator instructions have set up the V-memory as required, i.e., 20 in V7633 for the mode and 0202 in V7634 to designate the standard up/down with the absolute preset mode. By placing 0107 in V7636, an external reset for counter CT174 is selected and it will execute interrupt 0 on the rising edge of the reset. Presets for up/down counting have been stored in memory locations V3630 through V3635. The next even numbered location following this has FFFF to indicate we have no more presets.

Program Example 2: Up/Down Counting with Standard Inputs

In this example, there is a conveyor belt "A" that transports bottles to be inspected. During the course of the process, one sensor is keeping track of the bottles that are going onto belt "A" for inspection, and another sensor is keeping track of how many bottles are being removed to the finished product line.

When we have reached 500 bottles in the process, an "over 500" light turns on and a rerouting gate is activated to channel the incoming bottles to conveyor belt "B". The rerouting gate will stay activated for 30 seconds after the conveyor belt "A" contains less than 500 bottles.

The program below shows how ladder logic might be written to handle the job. Note the use of V1174. This memory location stores the current count for CT174 which is used with the DL06.



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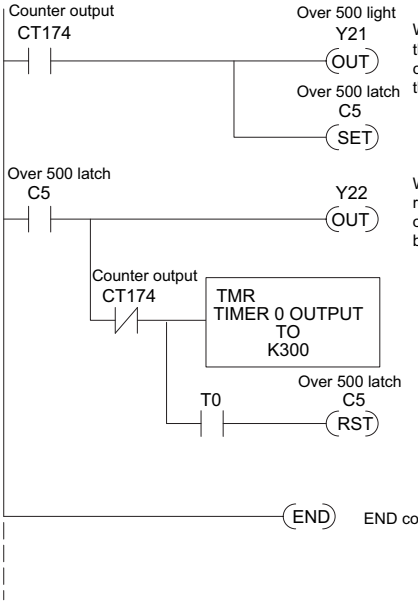
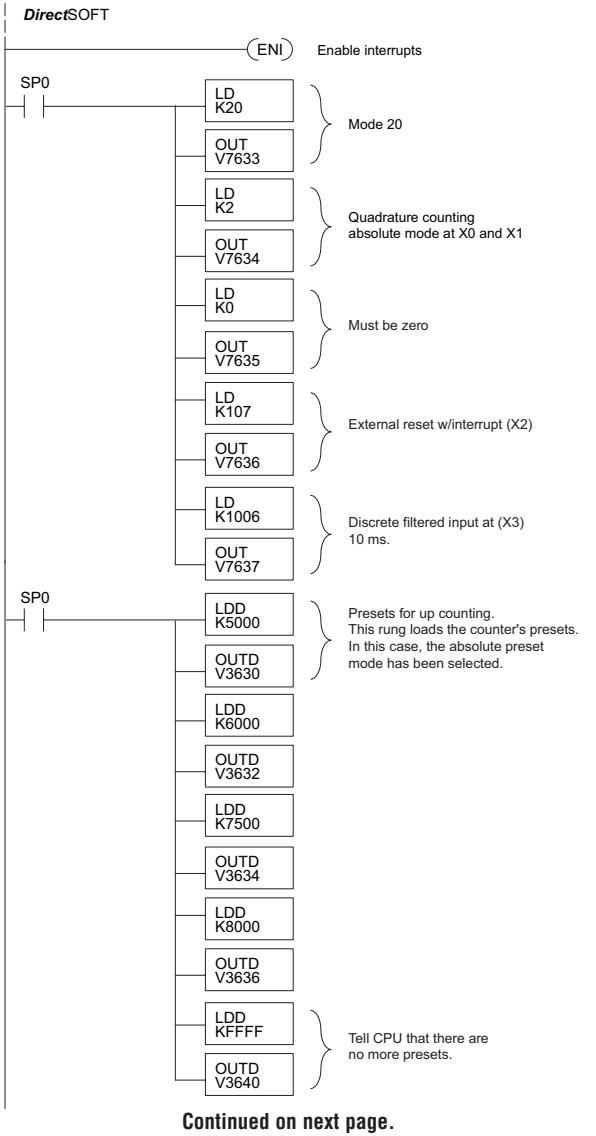


Program Example 3: Quadrature Counting

In this example, a wooden workpiece is being drilled with 3 holes and then the holes are injected with glue for dowels to be inserted at another workstation. A quadrature encoder is connected to a positioning table which is moving a drill press horizontally over the workpiece. The positioning table will stop and the drill press will lower to drill a hole in an exact location. After the three holes are drilled in the workpiece, the positioning table reverses direction and injects glue into the same holes.



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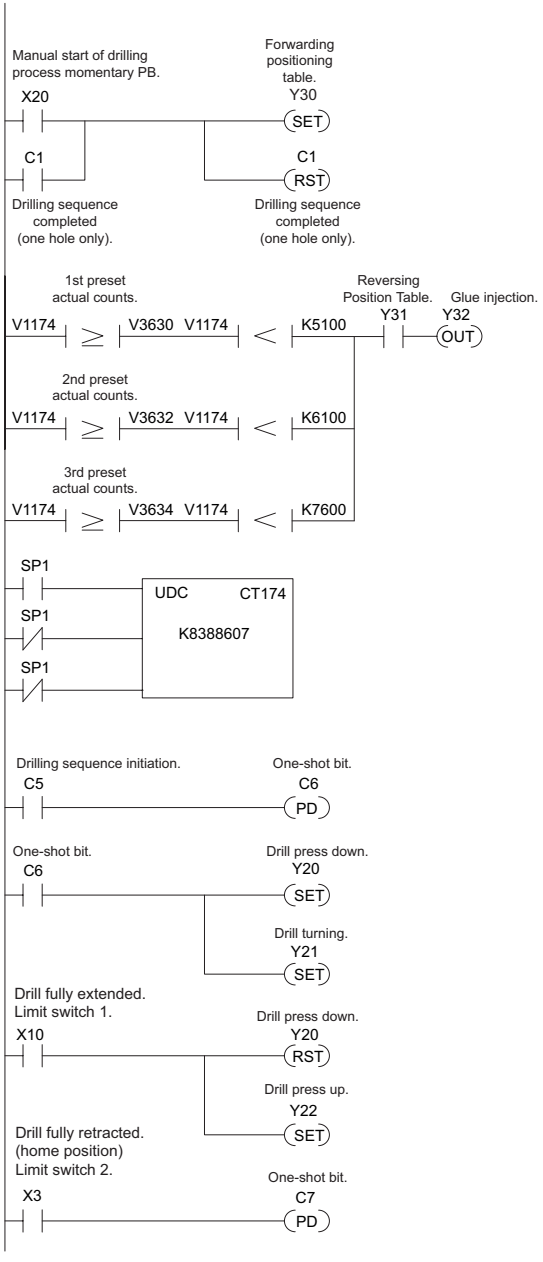

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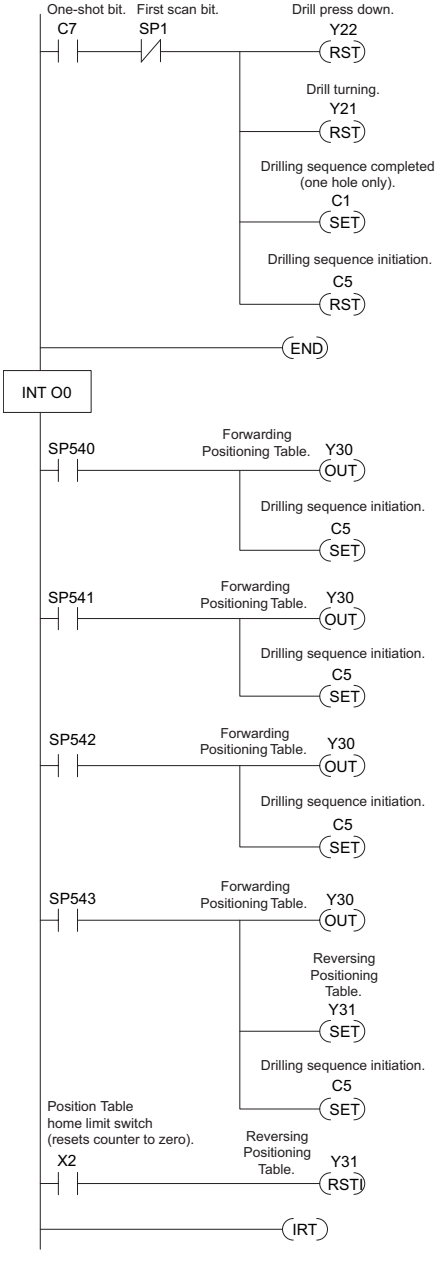


Troubleshooting Guide for Mode 20

If you're having trouble with Mode 20 operation, please study the following symptoms and possible causes. The most common problems are listed below.

Symptom: The counter does not count.

Possible causes:

1. **Field sensor and wiring** – Verify that the encoder or other field device inputs actually turn on and illuminate the status LEDs for X0 and X1. A standard incremental encoder will visibly, alternately turn on the LEDs for X0 and X1 when rotating slowly (1 RPM). Or, the problem could be due to a sinking-sourcing wiring problem, etc. Remember to check the signal ground connection. Also verify that the pulse on-time, duty cycle, voltage level, and frequency are within the input specifications.
2. **Configuration** – make sure all of the configuration parameters are correct. V7633 must be set to 20, and V7634 must be set to "0002" to enable the Phase A input, and V7635 must be set to "0000" to enable the Phase B input.
3. Stuck in reset – check the input status of the reset input, X2. If X2 is on, the counter will not count because it is being held in reset.
4. **Ladder program** – make sure you are using counter CT174 in your program. The top input is the enable signal for the counter. It must be on before the counter will count. The middle input is the dummy input and must be off for the counter to count. The bottom input is the counter reset, and must be off during counting.

Symptom: The counter counts in the wrong direction (up instead of down, and visa-versa).

Possible causes:

1. **Channel A and B assignment** – It's possible that Channel A and B assignments of the encoder wires is backwards from the desired rotation/counting orientation. Just swap the X0 and X1 inputs, and the counting direction will be reversed.

Symptom: The counter counts up and down but will not reset.

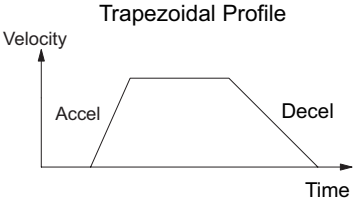
Possible causes:

1. Check the LED status indicator for X2 to make sure it is active when you want a reset. Also verify the configuration register V7636 for X2 is set to 7. Or, if you are using an internal reset, use the status mode of *Direct*SOFT to monitor the reset input to the counter.

Mode 30: Pulse Output

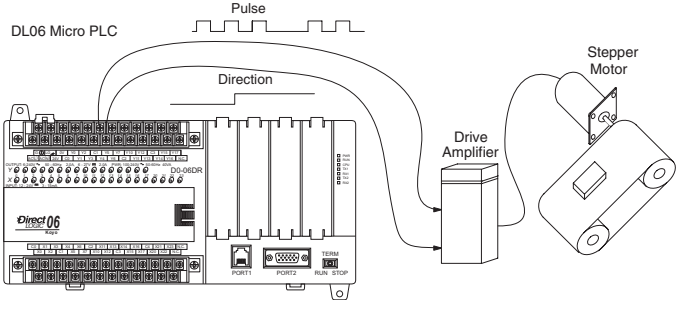
Purpose

The HSIO circuit in Mode 30 generates output pulse trains suitable for open-loop control of a single-axis motion positioning system. It generates pulse (stepper increment) and direction signals which you can connect to motor drive systems and perform various types of motion control. Using Mode 30 Pulse Output, you can select from three profile types detailed later in this appendix:

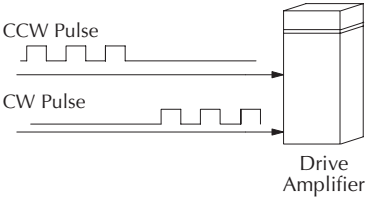


- **Automatic Trapezoidal** – Accel Slope to Target Velocity to Decel Slope
- **Step Trapezoidal** – User defined step acceleration/deceleration and target velocity
- **Velocity Control** – Speed and Direction only

The HSIO circuit becomes a high-speed pulse generator (up to 10 kHz) in Mode 30. By programming acceleration and deceleration values, position and velocity target values, the HSIO function automatically calculates the entire motion profile. The figure below shows the DL06 generating pulse and direction signals to the drive amplifier of a stepper positioning system. The pulses accomplish the profile independently and without interruption to ladder program execution in the CPU.



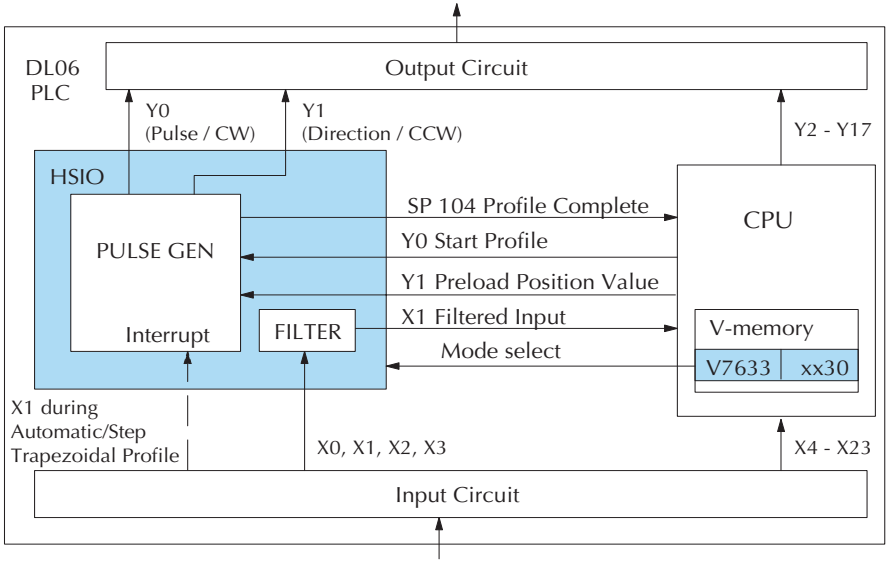
In the figure above, the DL06 generates pulse and direction signals. Each pulse represents the smallest increment of motion to the positioning system (such as one step or micro-step to a stepper system). Alternatively, the HSIO Pulse Output Mode may be configured to deliver counter clock-wise (CCW) and clock-wise (CW) pulse signals as shown to the right.



NOTE: *The pulse output is designed for open loop stepper motor systems. This, plus its minimum velocity of 40 pps, make it unsuitable for servo motor control.*

Functional Block Diagram

The diagram below shows HSIO functionality in Mode 30. When the lower byte of HSIO Mode register V7633 contains a BCD "30", the pulse output capability in the HSIO circuit is enabled. The pulse outputs use Y0 and Y1 terminals on the output connector. Remember that the outputs can only be DC type to operate.



IMPORTANT NOTE: *In Pulse Output Mode, Y0 and Y1 references are redefined or are used differently in two ways. Physical references refer to terminal screws, while logical references refer to I/O references in the ladder program. Please read the items below to understand this very crucial point.*

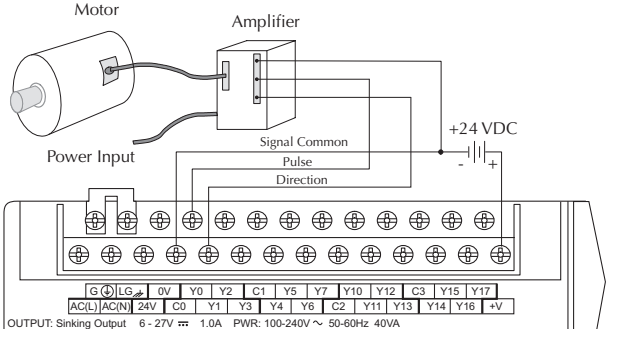
Notice the I/O point assignment and usage in the above diagram:

- X0, X1, X2 and X3 can be filtered inputs or pulse inputs in Pulse Output Mode, and they are available as input contacts to the ladder program.
- X1 behaves as an external interrupt to the pulse generator for automatic/step trapezoidal profiles. In other profile modes, it can be used as a filtered input or pulse input just like X0 (registration mode configuration shown above).
- References "Y0" and "Y1" are used in two different ways. At the discrete output connector, Y0 and Y1 terminals deliver the pulses to the motion system. The ladder program uses logical references Y0 and Y1 to initiate "Start Profile" and "Load Position Value" HSIO functions in Mode 30.

Hopefully, the above discussion will explain why some I/O reference names have dual meanings in Pulse Output Mode. **Please read the remainder of this section with care,** to avoid confusion about which actual I/O function is being discussed.

Wiring Diagram

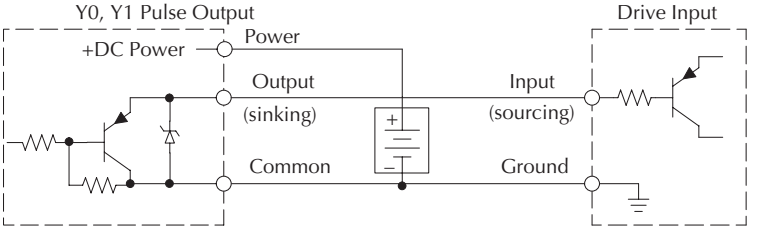
The generalized wiring diagram below shows pulse outputs Y0 and Y1 connected to the drive amplifier inputs of a motion control system.


Motor
Amplifier
+24 VDC
Power Input
Signal Common
Pulse
Direction
G LG 0V Y0 Y2 C1 Y5 Y7 Y10 Y12 C3 Y15 Y17
AC(L) AC(N) 24V C0 Y1 Y3 Y4 Y6 C2 Y11 Y13 Y14 Y16 +V
OUTPUT: Sinking Output 6 - 27V 1.0A PWR: 100-240V 50-60Hz 40VA

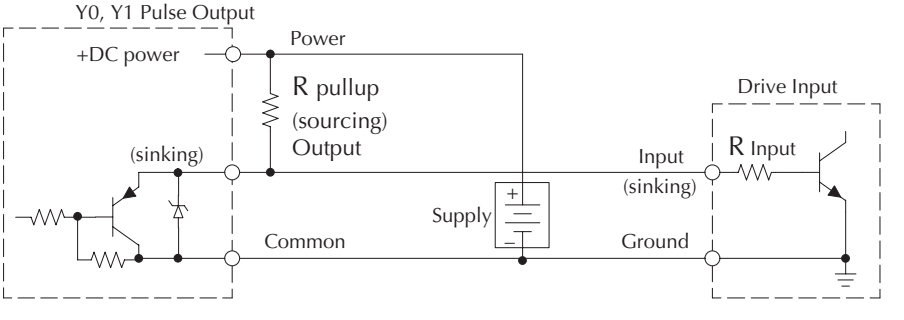
NOTE: *Do not use this drawing to wire your device. This is a general example and is not specific to any PLC model, stepper or encoder. Always refer to the device documentation for proper wiring connections.*

Interfacing to Drive Inputs

The pulse signals from Y0 and Y1 outputs will typically go to drive input circuits as shown above. It will be helpful to locate equivalent circuit schematics of the drive amplifier. The



following diagram shows how to interface to a sourcing drive input circuit.



Motion Profile Specifications

The motion control profiles generated in Pulse Output Mode have the following specifications:

Motion Control Profile Specifications	
Parameter	**Specification**
Profiles	Automatic Trapezoidal – Accel Slope / Target Velocity / Decel Slope
	Step Trapezoidal - Step Acceleration / Deceleration
	Velocity Control – Speed and Direction only
Position Range	–8388608 to 8388607
Positioning	Absolute / relative command
Velocity Range	40 Hz to 10 kHz
V-memory registers	V3630 to V3652 (Profile Parameter Table)
Current Position	CT174 and CT175 (V1174 and V1175)

Physical I/O Configuration

The configurable discrete I/O options for Pulse Output Mode are listed in the table below. The CPU uses SP 104 contact to sense "profile complete". V7632 is used to select pulse/direction or CW/CCW modes for the pulse outputs. Input X1 is dedicated as the external interrupt for use in registration mode.

Physical I/O Configuration			
Input	**Configuration Register**	**Function**	**Hex Code Required**
–	V7632	Y0 = Pulse Y1 = Direction	0103
		Y0 = CW Pulse Y1 = CCW Pulse	0003 (default)
X0	V7634	pulse input	0005
		filtered input	xx06, xx = filter time, 0-9 (BCD) (default)
X1	V7635	pulse input	0005
		filtered input	xx06, xx = filter time, 0-99 (BCD) (default)
X2	V7636	pulse input	0005
		filtered input	xx06, xx = filter time, 0-99 (BCD) (default)
X3	V7637	pulse input	0005
		filtered input	xx06, xx = filter time, 0-99 (BCD) (default)

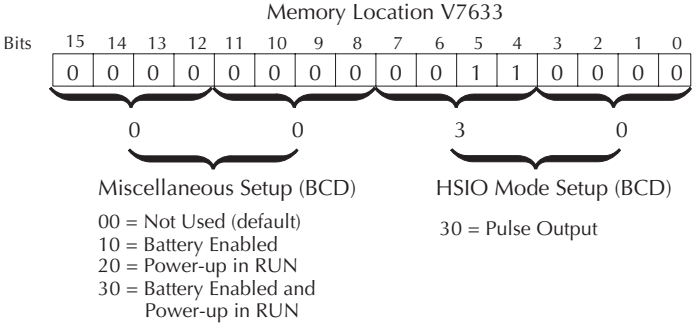
Logical I/O Functions

The following logical I/O references define functions that allow the HSIO to communicate with the ladder program.

Logical I/O/ Functions	
Logical I/O	**Function**
SP104	Profile Complete – the HSIO turns on SP104 to the CPU when the profile completes, and it goes back off when Start Profile (Y0) turns on.
X1	External Interrupt - If the interrupt feature is selected for the Automatic Trapezoidal profile or the Step Trapezoidal Profile, the DL06 keeps outputting pulses until X1 turns on. After it is on, the unit outputs the pulses that are defined as the Target position.
Y0	Start Profile – the ladder program turns on Y0 to start motion. If turned off before the move completes, motion stops. Turning it on again will start another profile, unless the current position equals the target position.
Y1	Preload Position Value – if motion is stopped and Start Profile is off, you can load a new value in CT174/CT175, and turn on Y1. At that transition, the value in CT174/CT175 becomes the current position.

Setup for Mode 30

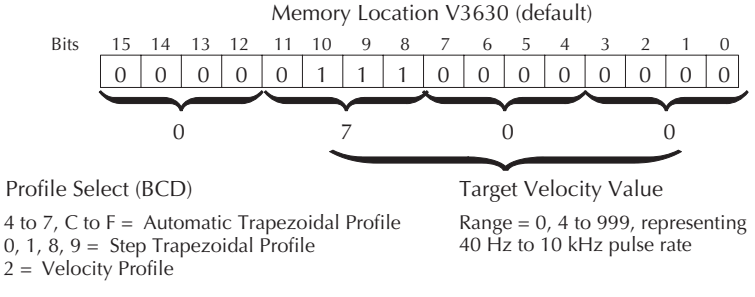
Recall that V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 30 in the lower byte of V7633 to select the High-Speed Counter Mode.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0
0 0 3 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
30 = Pulse Output

Choose the most convenient method of programming V7633 from the following:

- Include load and out instructions in your ladder program
- *Direct*SOFT's memory editor
- Use the Handheld Programmer D2–HPP

We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.


Memory Location V3630 (default)
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0
0 7 0 0
Profile Select (BCD)
4 to 7, C to F = Automatic Trapezoidal Profile
0, 1, 8, 9 = Step Trapezoidal Profile
2 = Velocity Profile
Target Velocity Value
Range = 0, 4 to 999, representing 40 Hz to 10 kHz pulse rate

Profile / Velocity Select Register

The first location in the Profile Parameter Table stores two key pieces of information. The upper four bits (12–15) select the type of profile required. The lower 12 bits (0-11) select the Target Velocity.

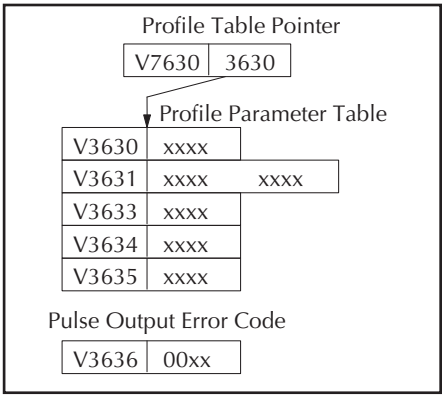
The ladder program must program this location before initiating any of the three profiles. The LD and OUT instruction will write all 16 bits, so be sure to fully specify the full four-digit BCD value for the Profile / Velocity Select Register each time.

The absolute and relative selection determines how the HSIO circuit will interpret your specified target position. Absolute position targets are referenced to zero. Relative position targets are referenced to the current position (previous target position). You may choose whichever reference method is most convenient for your application.

Profile Parameter Table

V7630 is a pointer location which points to the beginning of the Profile Parameter Table. The default starting location for the profile parameter table is V3630. However, you may change this by programming a different value in V7630. Remember to use the LDA (load address) instruction, converting octal into hex.

The HSIO uses the next V-memory register past the bottom of the profile parameter table to indicate profile errors. See the error table at the end of this section for error code definitions.



Automatic Trapezoidal Profile

V-Memory	Function	Range	Units
V3630, bits 12–15	Automatic Trapezoidal Profile without Ending Velocity (Ending Velocity is fixed to 0.)	4=absolute w/o interrupt 5=absolute with interrupt* C=relative w/o interrupt D=relative with interrupt*	–
	Automatic Trapezoidal Profile with Ending Velocity (Use V3637 to set up Ending Velocity.)	6=absolute w/o interrupt 7=absolute with interrupt* E=relative w/o interrupt F=relative with interrupt*	–
V3630, bits 0–11	Target Velocity	4 to 999 or 0 to 1000	x 10 pps
V3631 / V3632	Target Position**	–8388608 to 8388607	Pulses
V3633	Starting Velocity	4 to 100	x 10 pps
V3634	Acceleration Time	1 to 100	x 100 mS
V3635	Deceleration Time	1 to 100	x 100 mS
V3636	Error Code	(see end of section)	–
V3637	Ending Velocity	4 to 100	x 10 pps

* If you select to use interrupt, the DL06 will not start looking for your target count until the interrupt X1 is on.

**To set a negative number, put 8 in the most significant digit. For example: -8388608 is 88388608 in V3631 and V3632.

Step Trapezoidal Profile

V-Memory	Function	Range	Units
V3630, bits 12–15	Step Trapezoidal Profile	0=absolute w/o interrupt 7=absolute with interrupt* 8=relative w/o interrupt 9=relative with interrupt*	–
V3630, bits 0–11	Target Velocity	4 to 999 or 0 for 1000	x 10 pps
V3631 / V3632	Target Position**	–8388608 to 8388607	Pulses
V3633	Step 1 Acceleration	4 to 1000	x 10 pps
V3634	Step 1 Distance	1 to 9999	Pulses
V3635	Step 2 Acceleration	4 to 1000	x 10 pps
V3636	Step 2 Distance	1 to 9999	Pulses
V3637	Step 3 Acceleration	4 to 1000	x 10 pps
V3640	Step 3 Distance	1 to 9999	Pulses
V3641	Step 4 Acceleration	4 to 1000	x 10 pps
V3642	Step 4 Distance	1 to 9999	Pulses
V3643	Step 5 Deceleration	4 to 1000	x 10 pps
V3644	Step 5 Distance	1 to 9999	Pulses
V3645	Step 6 Deceleration	4 to 1000	x 10 pps
V3646	Step 6 Distance	1 to 9999	Pulses
V3647	Step 7 Deceleration	4 to 1000	x 10 pps
V3650	Step 7 Distance	1 to 9999	Pulses
V3651	Step 8 Deceleration	4 to 1000	x 10 pps
V3652	Step 8 Distance	1 to 9999	Pulses

* If you select to use interrupt, the DL06 will not start looking for your target count until the interrupt X1 is on.

**To set a negative number, put 8 in the most significant digit. For example: -8388608 is 88388608 in V3631 and V3632.

Velocity Control

V-Memory	Function	Range	Units
V3630	Velocity Profile	2000 only	–
V3631 / 3632	Direction Select	0=CW, 80000000=CCW,	Pulses
V3633	Velocity	4 to 1000	x 10 pps
V3636	Error Code	(see end of section)	–

Choosing the Profile Type

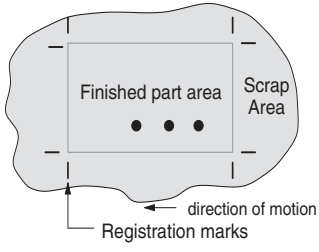
Pulse Output Mode generates three types of motion profiles. Most applications use one type for most moves. However, each move can be different if required.

- Automatic Trapezoidal – Accel Slope to Target Velocity to Decel Slope
- Step Trapezoidal – Velocity to Position Control on Interrupt
- Velocity Control – Speed and Direction only

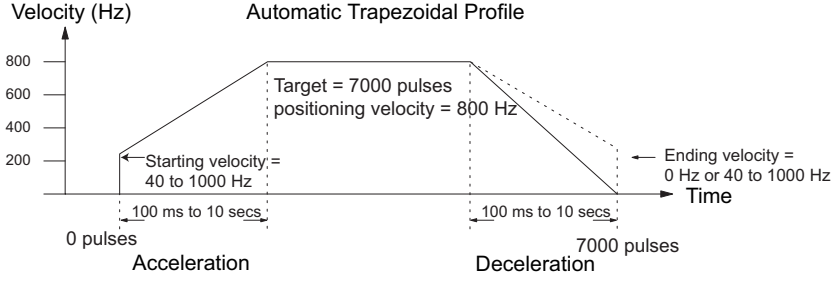
Automatic Trapezoidal Profile Defined

The automatic trapezoidal profile is the most common positioning profile. It moves the load to a pre-defined target position by creating a move profile. The acceleration slope is applied at the starting position. The deceleration slope is applied backwards from the target position. The remainder of the move in the middle is spent traveling at a defined velocity.

Registration profiles solve a class of motion control problems. In some applications, product material in work moves past a work tool such as a drill station. Shown to the right, registration marks on the scrap area of the work-piece allow a machine tool to register its position relative to the rectangle, to drill properly.



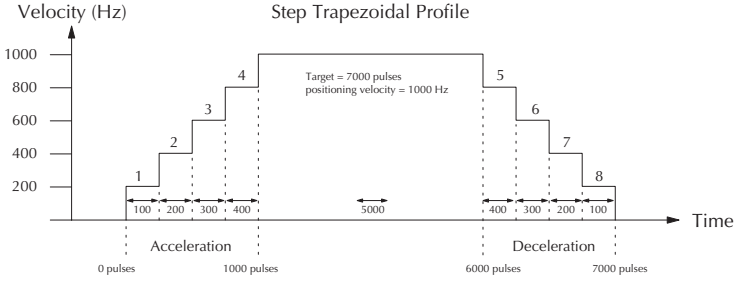
Home search moves allow open-loop motion systems to re-calibrate (preload) the current position value at powerup.



The user determines the starting velocity, the acceleration/deceleration times, and the total number of pulses. The CPU computes the profile from these inputs.

Step Trapezoidal Profiles Defined

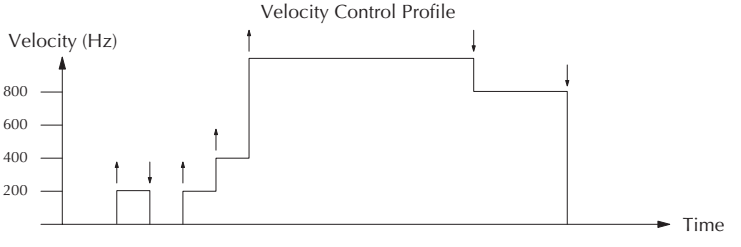
The step trapezoidal profile is a combination of velocity and position control modes. The move begins by accelerating to a programmed velocity. The velocity is sustained and the move is of indefinite duration. When an external interrupt signal occurs (due to registration sensing), the profile switches from velocity to position control. The move ends by continuing motion a pre-defined distance past the interrupt point (such as a drill hole location). The deceleration ramp is applied in advance of the target position.



Define steps 1 through 4 for gradual acceleration to the target velocity and define steps 5 through 8 for gradual deceleration from the target velocity. This type of profile is appropriate for applications involving large stepper motors and/or large inertia loads. It can, however, be used to provide gradual ramping in applications involving smaller motors and loads.

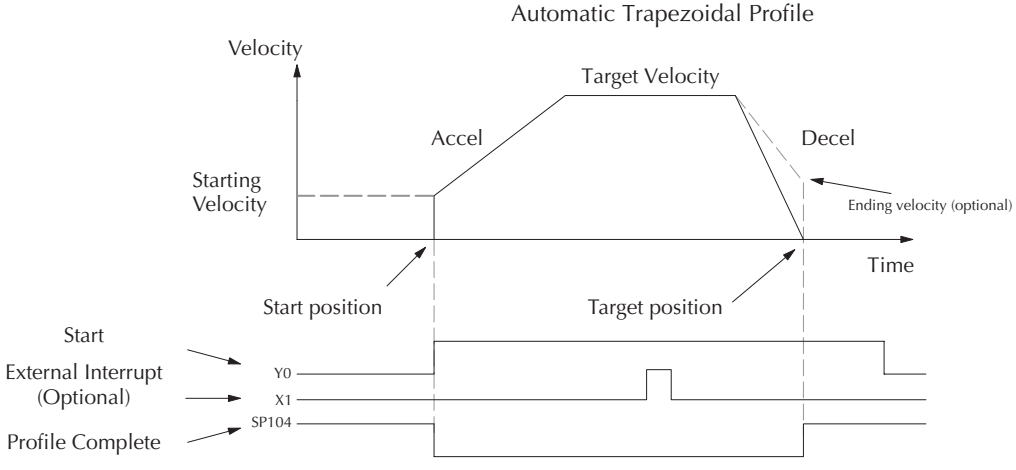
Velocity Control Defined

The Velocity Control defines only the direction and speed of motion. There is no target position specified, so the move can be of indefinite length. Only the first velocity value needs to be defined. The remaining velocity values can be created while motion is in progress. Arrows in the profile shown indicate velocity changes.



Automatic Trapezoidal Profile Operation

Starting velocities must be within the range of 40 pps to 1k pps. The remainder of the profile parameters are in the profile parameter table.



The time line of signal traces below the profile indicates the order of events. The HSIO uses logical output Y0 as the Start input to the HSIO, which starts the profile. Immediately the HSIO turns off the Profile Complete signal (SP104), so the ladder program can monitor the progress of the move. Typically, a ladder program will monitor this bit so it knows when to initiate the next profile move.

You can also use the external interrupt (X1). Once the external interrupt feature is selected for the profile, the DL06 keeps outputting the pulses until X1 turns on. Then, the DL06 outputs the pulses defined as the target position.

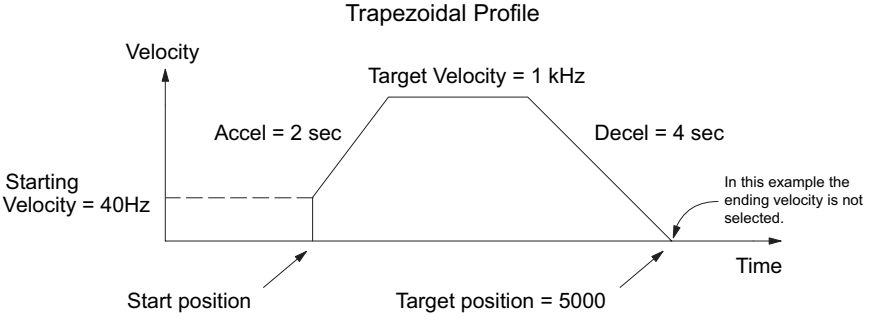
If you are familiar with motion control, you'll notice that we do not have to specify the direction of the move. The HSIO function examines the target position relative to the current position, and automatically outputs the correct direction information to the motor drive.

Notice that the motion accelerates immediately to the starting velocity. This segment is useful in stepper systems so we can jump past low speed areas when low-torque problems or a resonant point in the motor might cause a stall. (When a stepper motor stalls, we have lost the position of the load in open-loop positioning systems). However, it is preferable not to make the starting velocity too large, because the stepper motor will also *slip* some pulses due to the inertia of the system. You can also set up the ending velocity for the same reason.

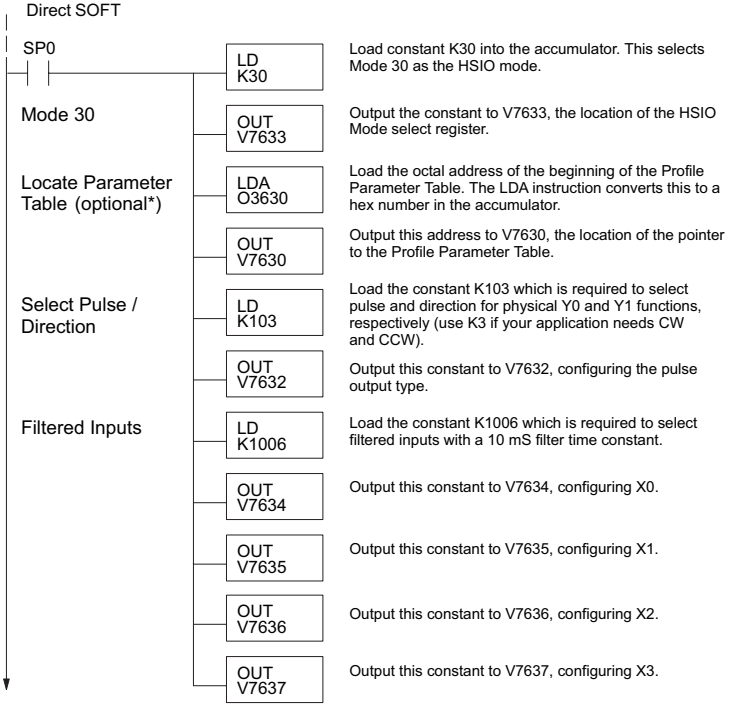
When you need to change the current position value, use logical Y1 output coil to load a new value into the HSIO counter. If the ladder program loads a new value in CT174/CT175 (V1174/V1175), then energizing Y1 will copy that value into the HSIO circuit counter. This must occur before the profile begins, because the HSIO ignores Y1 during motion.

Program Example 1: Automatic Trapezoidal Profile without External Interrupt

The Automatic Trapezoidal Profile we want to perform is drawn and labeled in the following figure. It consists of a non-zero starting velocity, and moderate target velocity.



The following program will realize the profile drawn above, when executed. The beginning of the program contains all the necessary setup parameters for Pulse Output Mode 30. We only have to do this once in the program, so we use first-scan contact SP0 to trigger the setup.


Direct SOFT
SP0
LD K30
Load constant K30 into the accumulator. This selects Mode 30 as the HSIO mode.
Mode 30
OUT V7633
Output the constant to V7633, the location of the HSIO Mode select register.
Locate Parameter Table (optional*)
LDA O3630
Load the octal address of the beginning of the Profile Parameter Table. The LDA instruction converts this to a hex number in the accumulator.
OUT V7630
Output this address to V7630, the location of the pointer to the Profile Parameter Table.
Select Pulse / Direction
LD K103
Load the constant K103 which is required to select pulse and direction for physical Y0 and Y1 functions, respectively (use K3 if your application needs CW and CCW).
OUT V7632
Output this constant to V7632, configuring the pulse output type.
Filtered Inputs
LD K1006
Load the constant K1006 which is required to select filtered inputs with a 10 mS filter time constant.
OUT V7634
Output this constant to V7634, configuring X0.
OUT V7635
Output this constant to V7635, configuring X1.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.

* If the Locate Parameter Table is not used you must remove both the LDA function and the OUT function below it.

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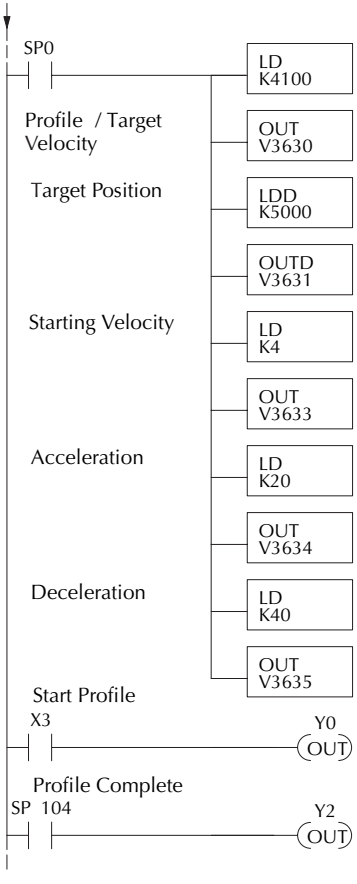


Load the constant K4100 which is required to select Automatic Trapzoidal Profile, absolute positioning, without interrupt and a target velocity of 1 kHz.

Output this constant to V3630, the location of the Profile Select / Starting Velocity setup register.

Load the constant K5000 which selects a target position of 5000 pulses. Don't forget to use double word size (8-digit BCD position value).

Output this constant to V3631 and V3632, the location of the Target Position double-word register .

Load the constant K4 which is required to select a starting velocity of 40 Hz (4 x 10 pps).

Output this constant to V3633, the location of the starting velocity parameter register .

Load the constant K20 which is required to select an acceleration time of 2 seconds (20 x 100 mS).

Output this constant to V3634, the location of the acceleration parameter register .

Load the constant K40 which is required to select a deceleration time of 4 seconds (40 x 100 mS).

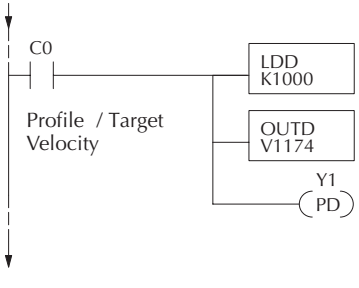
Output this constant to V3635, the location of the deceleration parameter register .

We use a spare filtered input to allow the operator to start the profile. When the operator turns X3 ON, logical output Y0 starts the profile. The operator must maintain X3 on unit until the profile is complete.

SP104 is the logical output of the HSIO to indicate the move is complete. We use Y2 to energize an annunciator that the profile has finished.

Preload Position Value

At any time you can write (preload) a new position into the current position value. This is often done after a home search (see the registration example programs).



Load the constant K1000 as the new current position value.

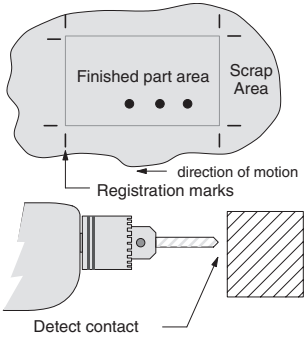
Output this constant to V1174/V1175 (CTA174/CTA175). the location of the current position value.

Turn on Y1 for 1 scan. The off-to-on transition causes the HSIO to preload the current position with the value in V1174/V1175.

Program Example 2: Automatic Trapezoidal Profile with External Interrupt

Registration Applications:

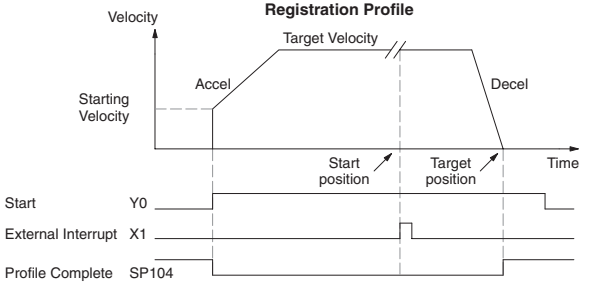
1. In a typical application shown to the right, product material in work moves past a work tool such as a drill. Registration marks on the scrap area of the work-piece allow a machine tool to register its position relative to the rectangle, to drill properly.



2. In other examples of registration, the work piece is stationary and the tool moves. A drill bit may approach the surface of a part in work, preparing to drill a hole of precise depth. However, the drill bit length gradually decreases due to tool wear. A method to overcome this is to detect the moment the drill makes contact with the surface of the part each time a part is drilled. The bit can then drill a constant depth after making contact with the part's surface.

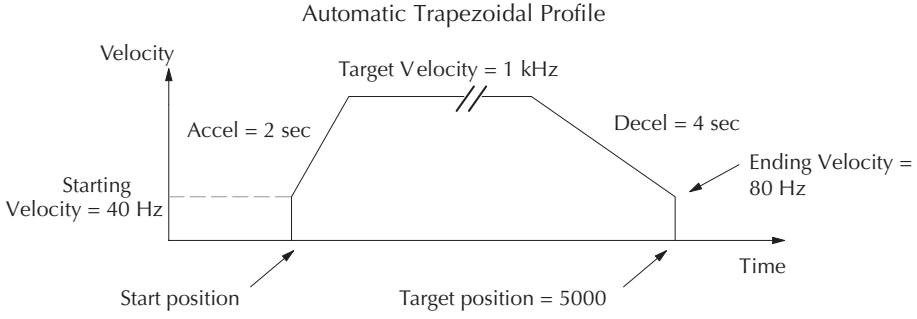
3. The home search move allows a motion system to calibrate its position on startup. In this case, the positioning system makes an indefinite move and waits for the load to pass by a home limit switch. This creates an interrupt at the moment when the load is in a known position. We then stop motion and preload the position value with a number which equates to the physical "home position".

When an interrupt pulse occurs on physical input X1, the starting position is declared to be the present count (current load position). The velocity control switches to position control, moving the load to the target position. Note that the minimum starting velocity is 40 pps. This instantaneous velocity accommodates stepper motors that can stall at low speeds.

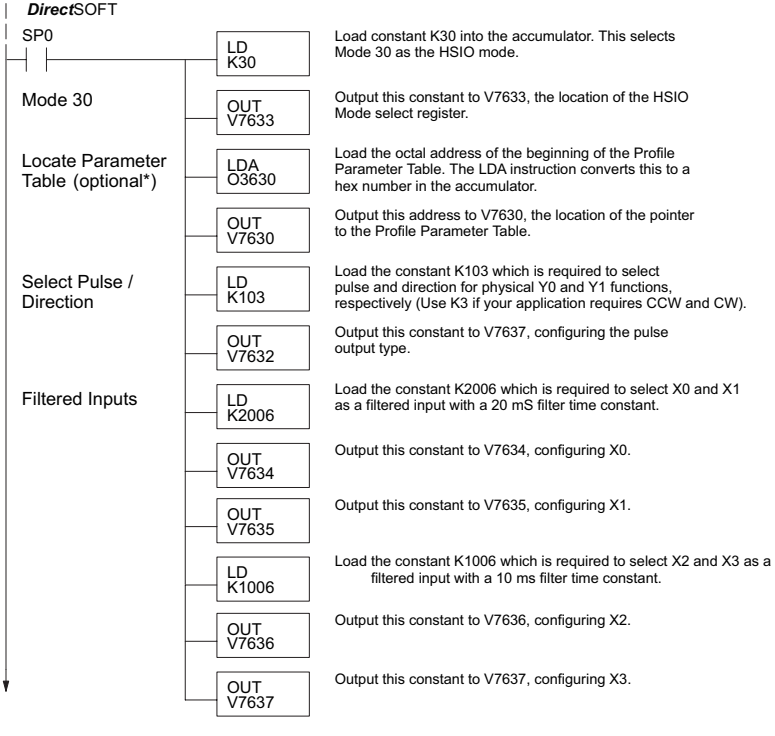


The time line of signal traces below the profile indicates the order of events. The CPU uses logical output Y0 to start the profile. Immediately the HSIO turns off the Profile Complete signal (SP104), so the ladder program can monitor the move's completion by sensing the signal's on state.

The Automatic Trapezoidal profile we want to perform is drawn and labeled in the following figure. It consists of a non-zero starting velocity, and moderate target velocity.



The following program will realize the profile drawn above, when executed. The first program rung contains all the necessary setup parameters. We only have to do this once in the program, so we use first-scan contact SP0 to trigger the setup.


DirectSOFT
SP0
LD K30
Load constant K30 into the accumulator. This selects Mode 30 as the HSIO mode.
Mode 30
OUT V7633
Output this constant to V7633, the location of the HSIO Mode select register.
Locate Parameter Table (optional*)
LDA O3630
Load the octal address of the beginning of the Profile Parameter Table. The LDA instruction converts this to a hex number in the accumulator.
OUT V7630
Output this address to V7630, the location of the pointer to the Profile Parameter Table.
Select Pulse / Direction
LD K103
Load the constant K103 which is required to select pulse and direction for physical Y0 and Y1 functions, respectively (Use K3 if your application requires CCW and CW).
OUT V7632
Output this constant to V7637, configuring the pulse output type.
Filtered Inputs
LD K2006
Load the constant K2006 which is required to select X0 and X1 as a filtered input with a 20 mS filter time constant.
OUT V7634
Output this constant to V7634, configuring X0.
OUT V7635
Output this constant to V7635, configuring X1.
LD K1006
Load the constant K1006 which is required to select X2 and X3 as a filtered input with a 10 ms filter time constant.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.

* If the Locate Parameter Table is not used you must remove both the LDA function and the OUT function below it.

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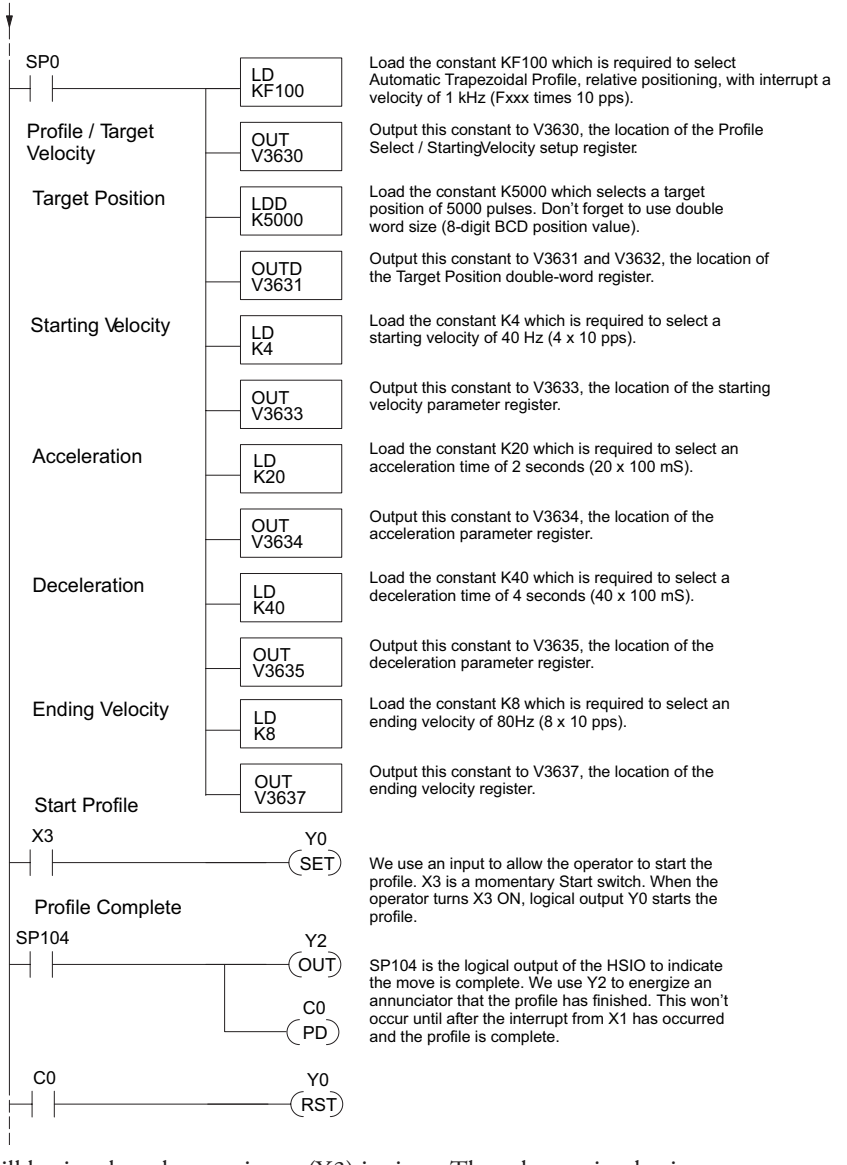
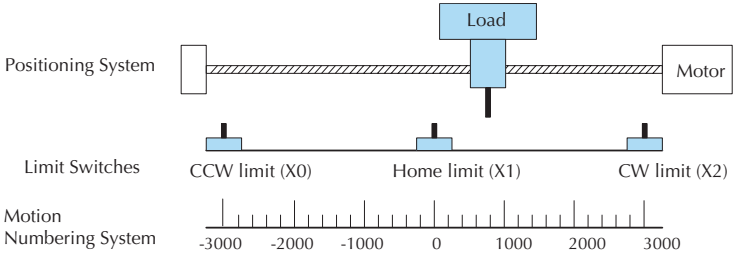

SP0
LD
KF100
Load the constant KF100 which is required to select Automatic Trapezoidal Profile, relative positioning, with interrupt a velocity of 1 kHz (Fxxx times 10 pps).
Profile / Target Velocity
OUT
V3630
Output this constant to V3630, the location of the Profile Select / StartingVelocity setup register.
Target Position
LDD
K5000
Load the constant K5000 which selects a target position of 5000 pulses. Don't forget to use double word size (8-digit BCD position value).
OUTD
V3631
Output this constant to V3631 and V3632, the location of the Target Position double-word register.
Starting Velocity
LD
K4
Load the constant K4 which is required to select a starting velocity of 40 Hz (4 x 10 pps).
OUT
V3633
Output this constant to V3633, the location of the starting velocity parameter register.
Acceleration
LD
K20
Load the constant K20 which is required to select an acceleration time of 2 seconds (20 x 100 mS).
OUT
V3634
Output this constant to V3634, the location of the acceleration parameter register.
Deceleration
LD
K40
Load the constant K40 which is required to select a deceleration time of 4 seconds (40 x 100 mS).
OUT
V3635
Output this constant to V3635, the location of the deceleration parameter register.
Ending Velocity
LD
K8
Load the constant K8 which is required to select an ending velocity of 80Hz (8 x 10 pps).
OUT
V3637
Output this constant to V3637, the location of the ending velocity register.
Start Profile
X3
Y0
SET
We use an input to allow the operator to start the profile. X3 is a momentary Start switch. When the operator turns X3 ON, logical output Y0 starts the profile.
Profile Complete
SP104
Y2
OUT
C0
PD
SP104 is the logical output of the HSIO to indicate the move is complete. We use Y2 to energize an annunciator that the profile has finished. This won't occur until after the interrupt from X1 has occurred and the profile is complete.
C0
Y0
RST

The profile will begin when the start input (X3) is given. Then the motion begins an indefinite move, which lasts until an external interrupt on X1 occurs. Then the motion continues on for 5000 more pulses before stopping.

Program Example 3: Automatic Trapezoidal Profile with Home Search

One of the more challenging aspects of motion control is the establishment of actual position at powerup. This is especially true for open-loop systems which do not have a position feedback device. However, a simple limit switch located at an exact location on the positioning mechanism can provide "position feedback" at one point. For most stepper control systems, this method is a good and economical solution.

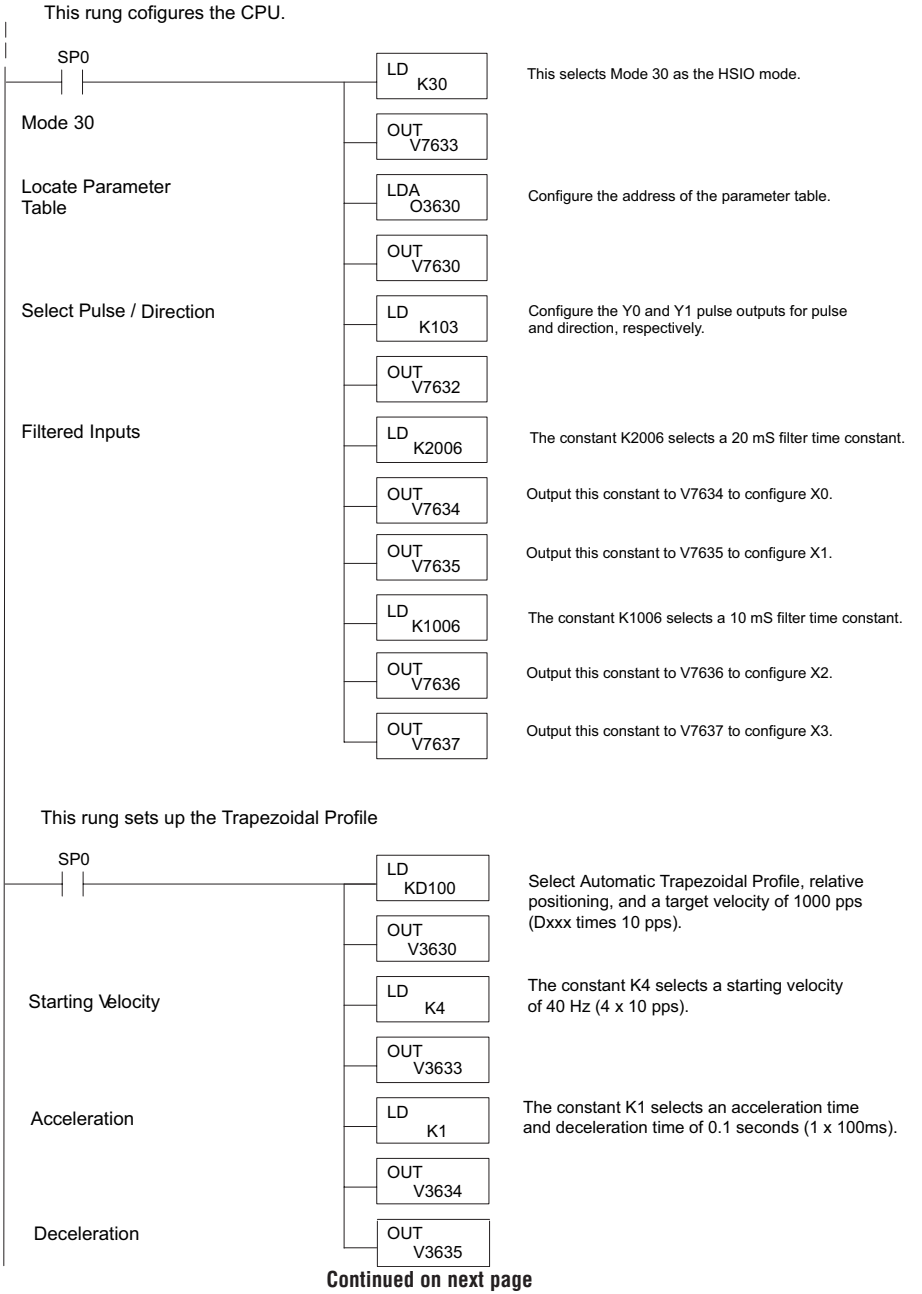


In the drawing above, the load moves left or right depending on the CW/CCW direction of motor rotation. The PLC ladder program senses the CW and CCW limit switches to stop the motor, before the load moves out-of-bounds and damages the machine. The home limit switch is used at powerup to establish the actual position. The numbering system is arbitrary, depending on a machine's engineering units.

At powerup, we do not know whether the load is located to the left or to the right of the home limit switch. Therefore, we will initiate a home search profile, using the registration mode. The home limit switch is wired to X1, causing the interrupt. The example, beginning on the next page, preferentially starts in one direction only (CW), and pulses until it reaches the first Overtravel Limit (CW Limit). It will ignore the Home Switch if it passes it. This means that Homing is always accomplished from the same direction for better consistency.

The CPU will then reverse the direction of pulses (loads 80000200 into V3631) and travel away from the CW Limit until it hits the Home Switch, then travels past it and reverse slowly back to the Home Switch. A value of 0 will be loaded to V1174 (CTA174) to represent the Home position.

DirectSOFT


This rung cofigures the CPU.
SP0
LD K30
This selects Mode 30 as the HSIO mode.
Mode 30
OUT V7633
Locate Parameter Table
LDA O3630
Configure the address of the parameter table.
OUT V7630
Select Pulse / Direction
LD K103
Configure the Y0 and Y1 pulse outputs for pulse and direction, respectively.
OUT V7632
Filtered Inputs
LD K2006
The constant K2006 selects a 20 mS filter time constant.
OUT V7634
Output this constant to V7634 to configure X0.
OUT V7635
Output this constant to V7635 to configure X1.
LD K1006
The constant K1006 selects a 10 mS filter time constant.
OUT V7636
Output this constant to V7636 to configure X2.
OUT V7637
Output this constant to V7637 to configure X3.
This rung sets up the Trapezoidal Profile
SP0
LD KD100
Select Automatic Trapezoidal Profile, relative positioning, and a target velocity of 1000 pps (Dxxx times 10 pps).
OUT V3630
Starting Velocity
LD K4
The constant K4 selects a starting velocity of 40 Hz (4 x 10 pps).
OUT V3633
Acceleration
LD K1
The constant K1 selects an acceleration time and deceleration time of 0.1 seconds (1 x 100ms).
OUT V3634
Deceleration
OUT V3635

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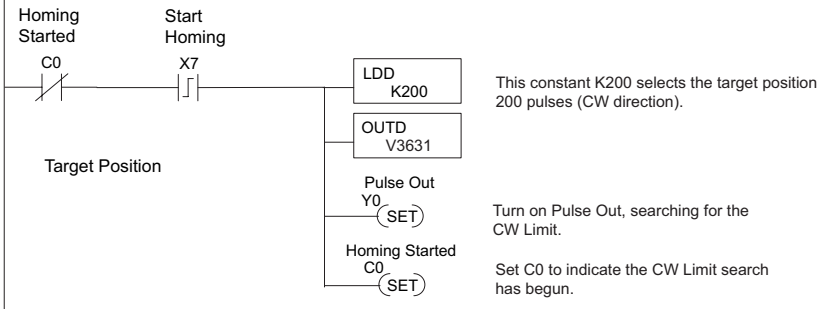
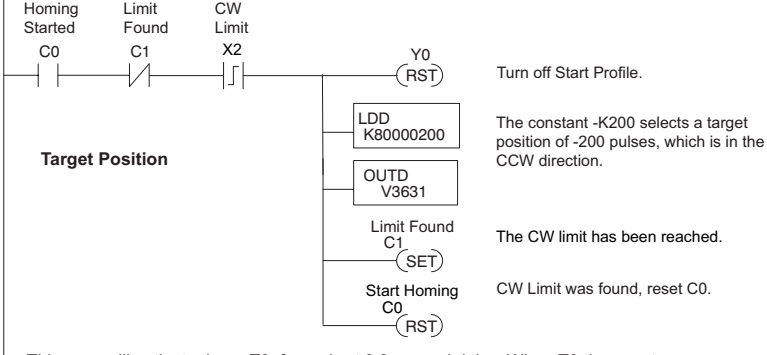
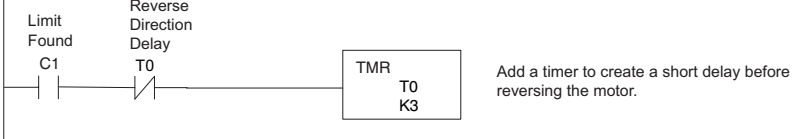
"Start Homing" is assigned as X7. This will set Y0, which starts the Pulse Output. Pulses will continue until the CCW Limit is reached.



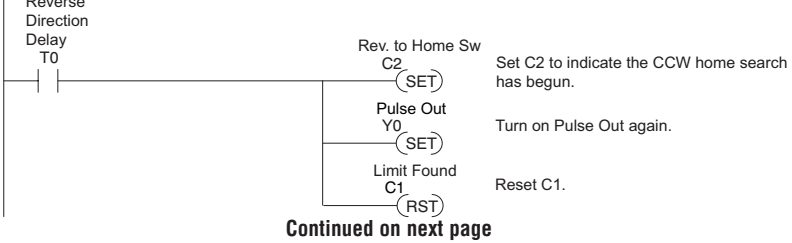
Once the CW Limit is found, the DL06 will stop the Pulse Output, load a negative value, thus reversing direction. It does this by LDD K80000200 into V3631. The "8" in the left-most position of the value loaded (8xxxxxxx) will cause Y1 to turn on. This is how the PLC reverses direction.



This rung will activate timer, T0, for a short 0.3 second delay. When T0 times out, the next rung is activated.



The Pulse Output is activated again, but in the reverse direction.



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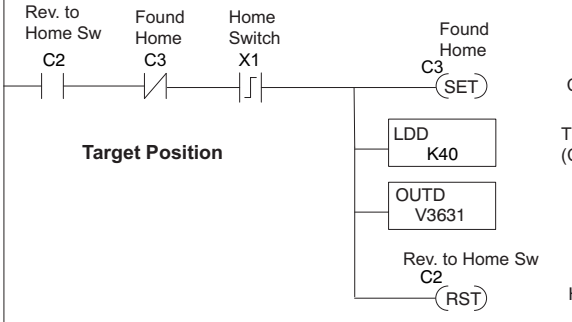
This rung waits until the Home Switch, X1, is triggered, then it prepares the next step by loading a new, slower, speed into V3631.
Notice that the value loaded is not in the form of 8xxxxxxx.



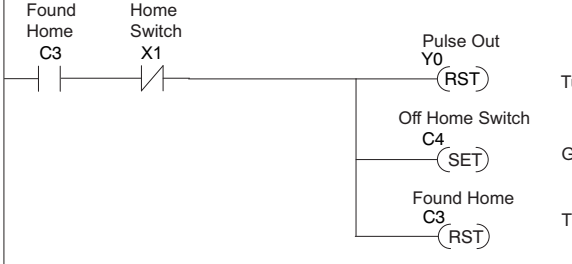
Target Position

CCW past home.

The constant K40 selects a target position count (CW direction).

Home Limit found, reset C2.

Once the Home Switch, X1, is deactivated, the Pulse Output is stopped.

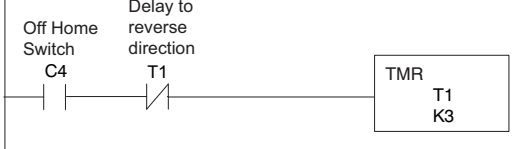


Turn Off Pulse Out.

Go in CW direction back to home.

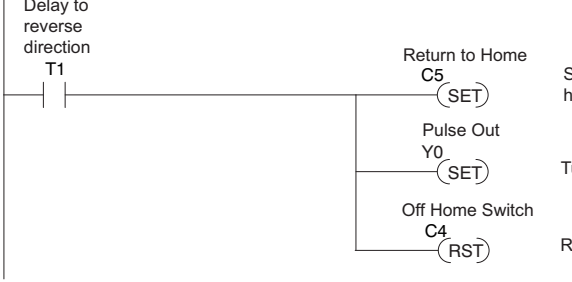
The Home Limit was passed, reset C3.

This rung adds a short delay of 0.3 seconds to delay the reversing of the motor.



Add a timer to create a short delay before reversing motor.

The Pulse Output is now activated again, but in the direction the motor was initially started.



Set C5 to indicate the CW home search has begun.

Turn on Pulse Out again.

Reset C4.

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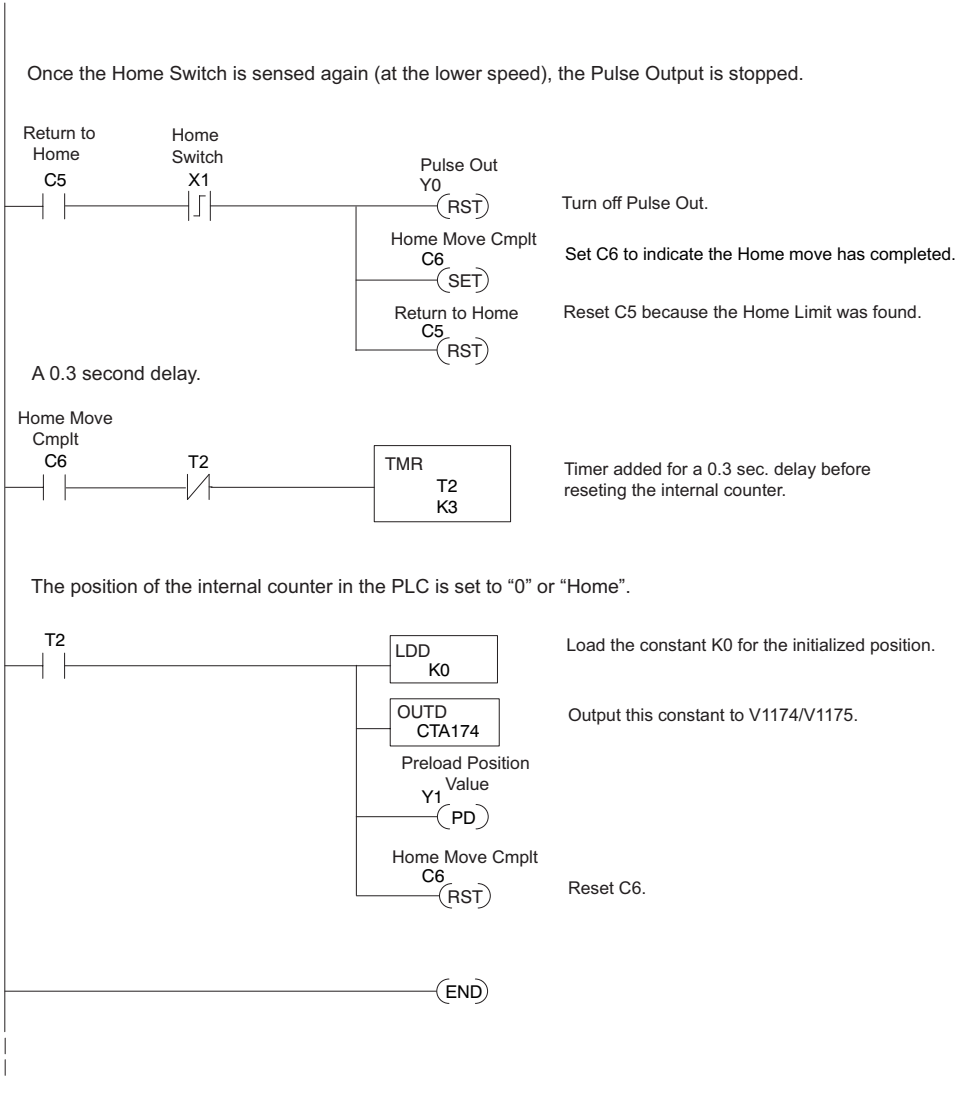
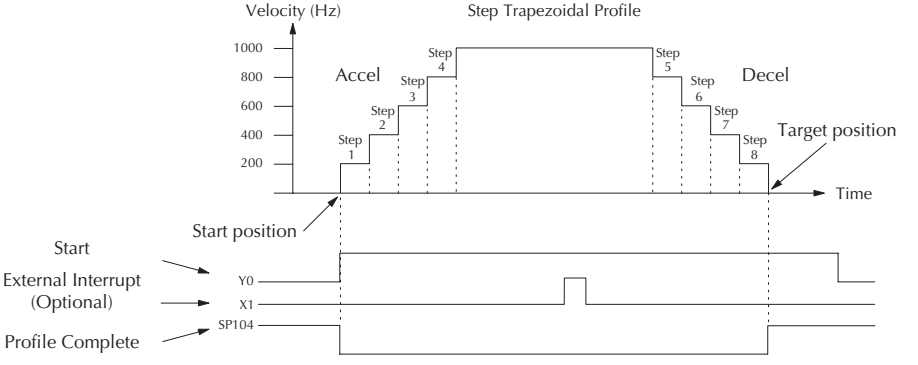


The home search profile will execute specific parts of the program, based on the order of detection of the limit switches. Ladder logic sets C0 to initiate a home search in the CW direction. If the CW limit is encountered, the program searches for home in the CCW direction, passes it slightly, and does the final CW search for home. After reaching home, the last ladder rung preloads the current position to “0”.

Step Trapezoidal Profile Operation

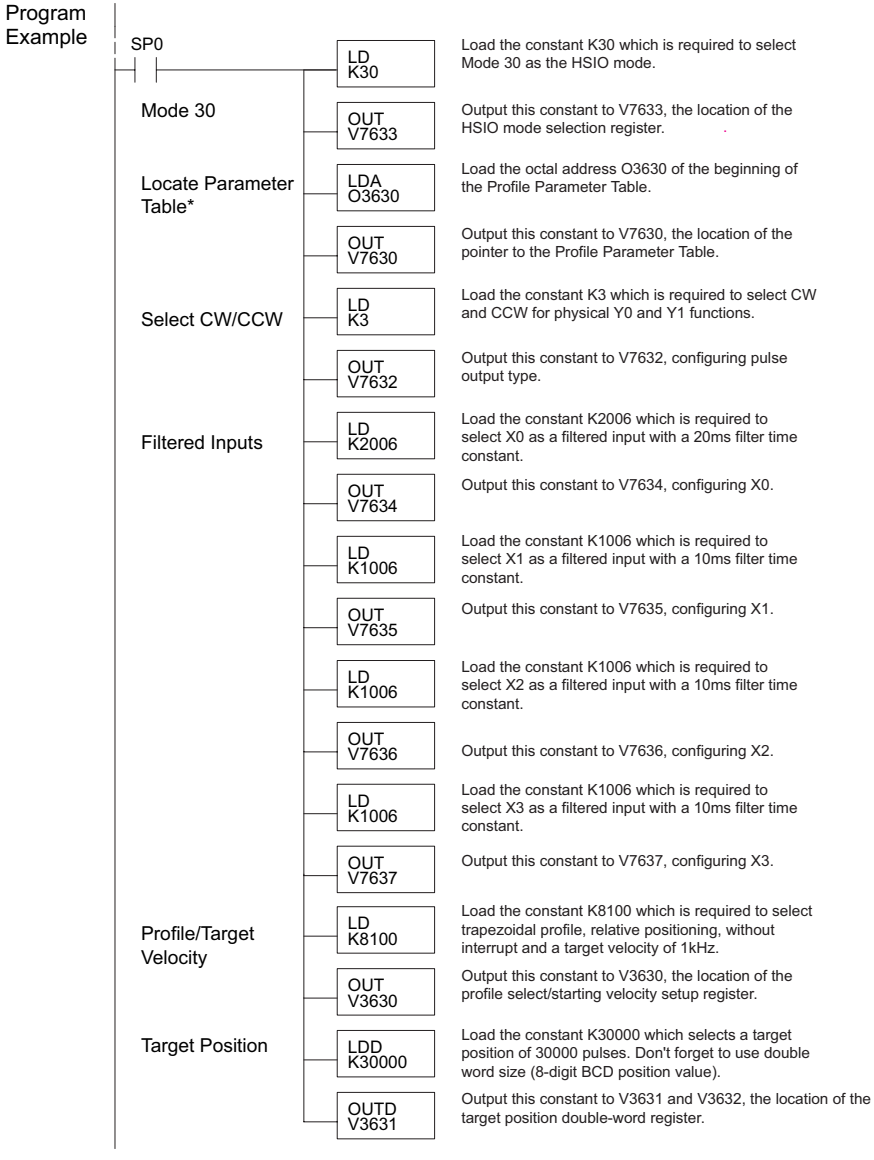
With this step trapezoidal profile, you can control the acceleration and deceleration slopes as you want.



The time line of signal traces below the profile indicates the order of events. The HSIO uses logical output Y0 as the start input to the HSIO, which starts the profile. Immediately, the HSIO turns off the Profile Complete signal (SP104), so the ladder program can monitor the progress of the move. Typically, a ladder program will monitor this bit so it knows when to initiate the next profile move. You can also use the external interrupt (X1). Once the external interrupt feature selected for the profile, the DL06 keeps outputting the pulses until X1 turns on. Then the DL06 outputs the pulses defined as the target position.

Each acceleration and deceleration slope consists of 4 steps. You can set up the velocity and the distance (number of pulses) of each step. You don't need to use all 4 steps of each slope. For instance, if you want to use only 2 steps, just set zero to the velocity and the distance of the 3rd and 4th step. If the acceleration slope and the deceleration slope are identical, you can just put zero into all the velocity and the distance parameters for the deceleration slope.

Program Example 4: Step Trapezoidal Profile


Program Example
SP0
LD K30
Load the constant K30 which is required to select Mode 30 as the HSIO mode.
Mode 30
OUT V7633
Output this constant to V7633, the location of the HSIO mode selection register.
Locate Parameter Table*
LDA O3630
Load the octal address O3630 of the beginning of the Profile Parameter Table.
OUT V7630
Output this constant to V7630, the location of the pointer to the Profile Parameter Table.
Select CW/CCW
LD K3
Load the constant K3 which is required to select CW and CCW for physical Y0 and Y1 functions.
OUT V7632
Output this constant to V7632, configuring pulse output type.
Filtered Inputs
LD K2006
Load the constant K2006 which is required to select X0 as a filtered input with a 20ms filter time constant.
OUT V7634
Output this constant to V7634, configuring X0.
LD K1006
Load the constant K1006 which is required to select X1 as a filtered input with a 10ms filter time constant.
OUT V7635
Output this constant to V7635, configuring X1.
LD K1006
Load the constant K1006 which is required to select X2 as a filtered input with a 10ms filter time constant.
OUT V7636
Output this constant to V7636, configuring X2.
LD K1006
Load the constant K1006 which is required to select X3 as a filtered input with a 10ms filter time constant.
OUT V7637
Output this constant to V7637, configuring X3.
Profile/Target Velocity
LD K8100
Load the constant K8100 which is required to select trapezoidal profile, relative positioning, without interrupt and a target velocity of 1kHz.
OUT V3630
Output this constant to V3630, the location of the profile select/starting velocity setup register.
Target Position
LDD K30000
Load the constant K30000 which selects a target position of 30000 pulses. Don't forget to use double word size (8-digit BCD position value).
OUTD V3631
Output this constant to V3631 and V3632, the location of the target position double-word register.

* If the Locate Parameter Table is not used you must remove both the LDA function and the OUT function below it.

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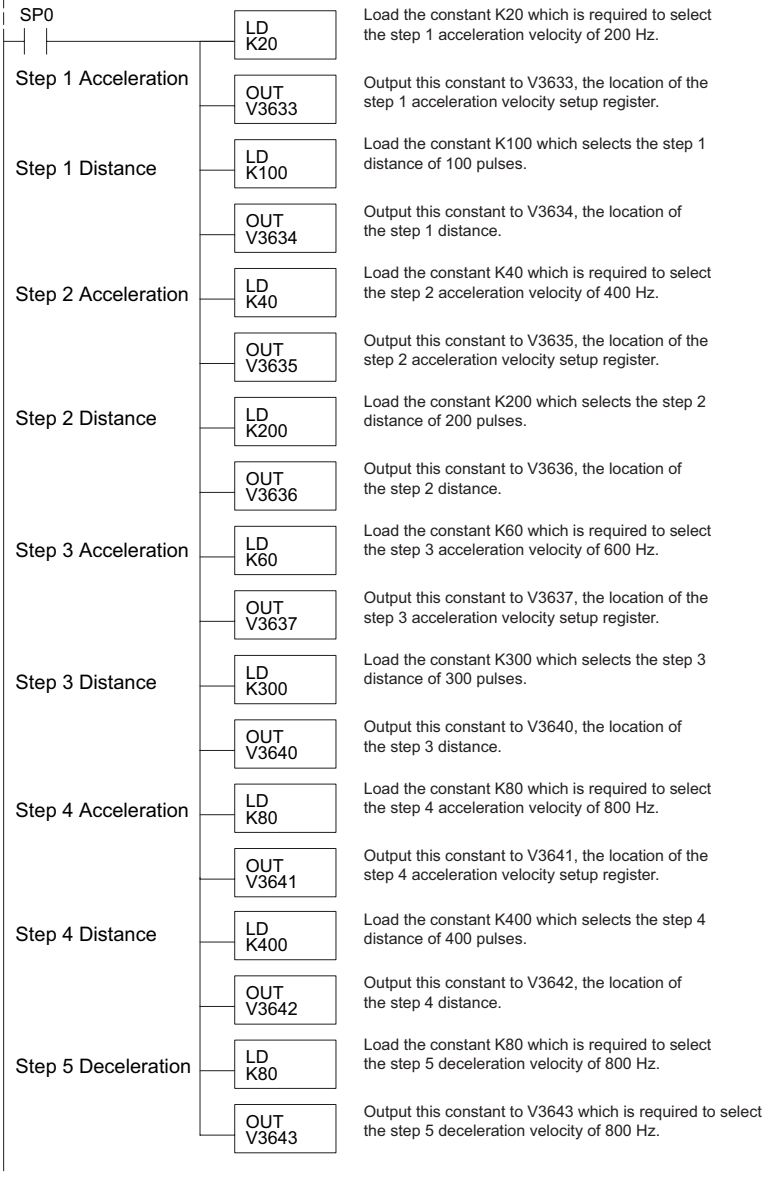
Program Example


SP0
LD K20
Load the constant K20 which is required to select the step 1 acceleration velocity of 200 Hz.
Step 1 Acceleration
OUT V3633
Output this constant to V3633, the location of the step 1 acceleration velocity setup register.
Step 1 Distance
LD K100
Load the constant K100 which selects the step 1 distance of 100 pulses.
OUT V3634
Output this constant to V3634, the location of the step 1 distance.
Step 2 Acceleration
LD K40
Load the constant K40 which is required to select the step 2 acceleration velocity of 400 Hz.
OUT V3635
Output this constant to V3635, the location of the step 2 acceleration velocity setup register.
Step 2 Distance
LD K200
Load the constant K200 which selects the step 2 distance of 200 pulses.
OUT V3636
Output this constant to V3636, the location of the step 2 distance.
Step 3 Acceleration
LD K60
Load the constant K60 which is required to select the step 3 acceleration velocity of 600 Hz.
OUT V3637
Output this constant to V3637, the location of the step 3 acceleration velocity setup register.
Step 3 Distance
LD K300
Load the constant K300 which selects the step 3 distance of 300 pulses.
OUT V3640
Output this constant to V3640, the location of the step 3 distance.
Step 4 Acceleration
LD K80
Load the constant K80 which is required to select the step 4 acceleration velocity of 800 Hz.
OUT V3641
Output this constant to V3641, the location of the step 4 acceleration velocity setup register.
Step 4 Distance
LD K400
Load the constant K400 which selects the step 4 distance of 400 pulses.
OUT V3642
Output this constant to V3642, the location of the step 4 distance.
Step 5 Deceleration
LD K80
Load the constant K80 which is required to select the step 5 deceleration velocity of 800 Hz.
OUT V3643
Output this constant to V3643 which is required to select the step 5 deceleration velocity of 800 Hz.

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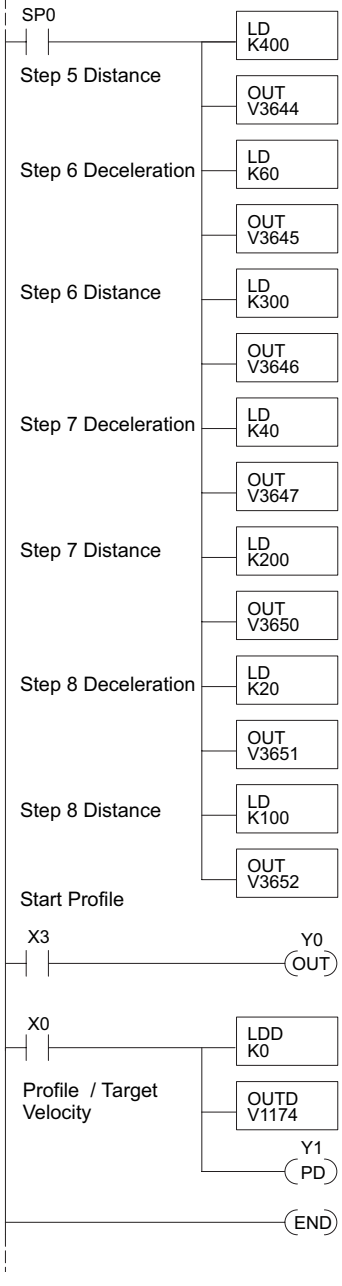
Program Example



Load the constant K400 which selects the step 5 distance of 400 pulses.

Output this constant to V3644, the location of the step 5 distance.

Load the constant K60 which is required to select the step 6 deceleration velocity of 600 Hz.

Output this constant to V3645, which is required to select the step 6 deceleration velocity of 600 Hz.

Load the constant K300 which selects the step 6 distance of 300 pulses.

Output this constant to V3646, the location of the step 6 distance.

Load the constant K40 which is required to select the step 6 deceleration velocity of 400 Hz.

Output this constant to V3647, which is required to select the step 6 deceleration velocity of 400 Hz.

Load the constant K200 which selects the step 7 distance of 200 pulses.

Output this constant to V3650, the location of the step 7 distance.

Load the constant K20 which is required to select the step 8 deceleration velocity of 200 Hz.

Output this constant to V3651, which is required to select the step 8 deceleration velocity of 200 Hz.

Load the constant K100 which selects the step 8 distance of 100 pulses.

Output this constant to V3652, the location of the step 8 distance.

We use a spare filtered input to allow the operator to start the profile. When the operator turns X3 ON, logical output Y0 starts the profile. The operator must maintain X3 on until the profile is complete.

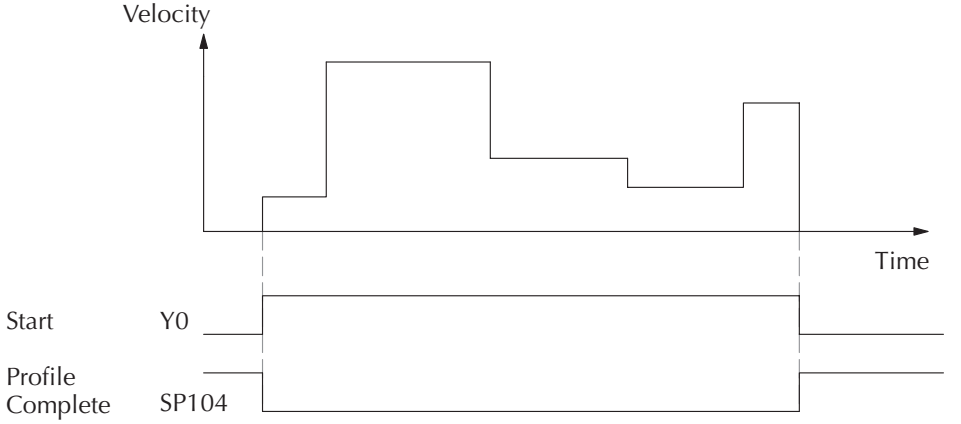
Load value.

Output this constant to V1174/V1175 (CT174/CT175), the location of the current position value.

Turn on Y1 for 1 scan. The of-to-on transition causes the HSIO to preload the current position with the value in V1174/V1175.

Velocity Profile Operation

The velocity profile is best suited for applications which involve motion but do not require moves to specific points. Conveyor speed control is a typical example.



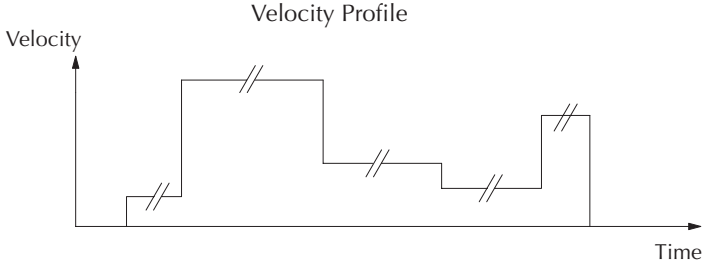
The time line of signal traces below the profile indicates the order of events. Assuming the velocity is set greater than zero, motion begins when the Start input (Y0) energizes. Since there is no end position target, the profile is considered in progress as long as the Start input remains active. The profile complete logical input to ladder logic (X0) correlates directly to the Start input status when velocity profiles are in use.

While the Start input is active, the ladder program can command a velocity change by writing a new value to the velocity register (V3633 by default). The full speed range of 40 Hz to 10 kHz is available. Notice from the drawing that there are no acceleration or deceleration ramps between velocity updates. This is how velocity profiling works with the HSIO. However, the ladder program can command more gradual velocity changes by incrementing or decrementing the velocity value more slowly. A counter or timer can be useful in creating your own acceleration/deceleration ramps. Unless the load must do a very complex move, it is easier to let the HSIO function generate the accel/decel ramps by selecting the trapezoidal or registration profiles, instead.

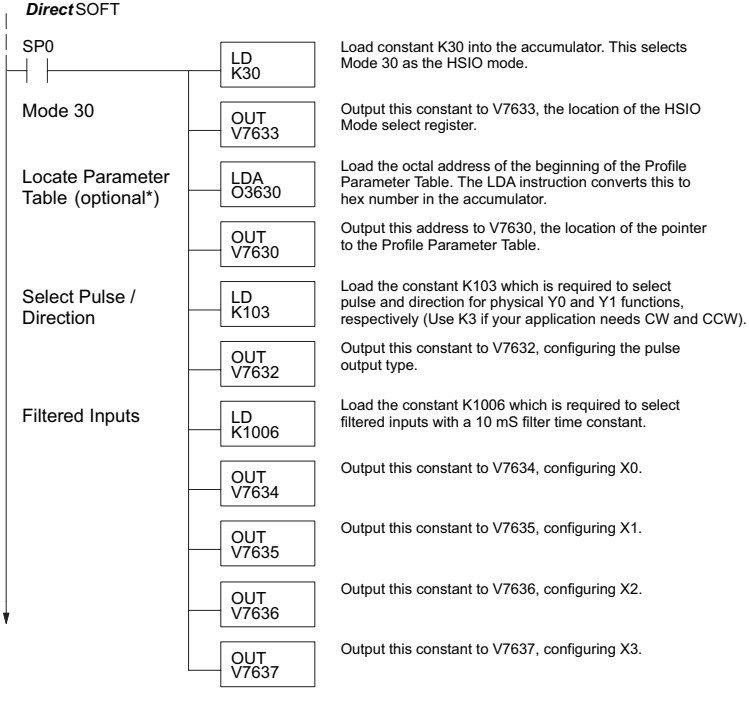
Unlike the trapezoidal and registration profiles, you must specify the desired direction of travel with velocity profiles. Load the direction select register (V3631/V3632 by default) with 8000 0000 hex for CCW direction, or 0 for CW direction.

Program Example 5: Velocity Profile

The velocity profile we want to perform is drawn and labeled in the following figure. Each velocity segment is of indefinite length. The velocity only changes when ladder logic (or other device writing to V-memory) updates the velocity parameter.

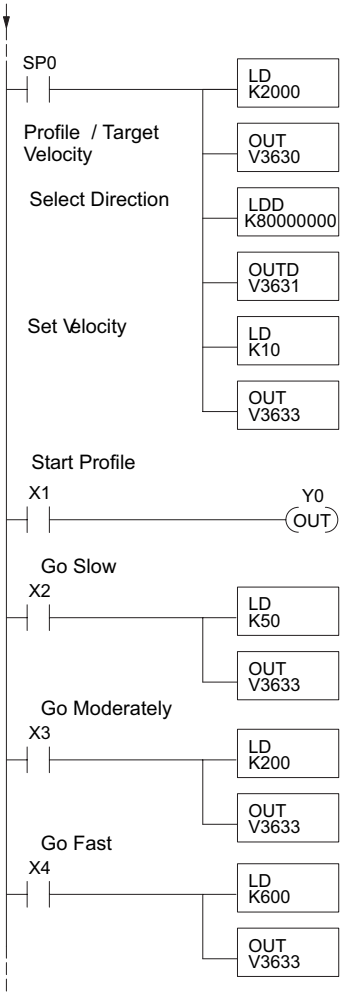


The following program uses dedicated discrete inputs to load in new velocity values. This program is fun to try, because you can create an infinite variety of profiles with just two or three input switches. The intent is to turn on only one of X2, X3, or X4 at a time. The beginning of the program contains all the necessary setup parameters for Pulse Output Mode 30. We only have to do this once in the program, so we use first-scan contact SP0 to trigger the setup.


DirectSOFT
SP0
Mode 30
Locate Parameter Table (optional*)
Select Pulse / Direction
Filtered Inputs
LD K30
Load constant K30 into the accumulator. This selects Mode 30 as the HSIO mode.
OUT V7633
Output this constant to V7633, the location of the HSIO Mode select register.
LDA O3630
Load the octal address of the beginning of the Profile Parameter Table. The LDA instruction converts this to hex number in the accumulator.
OUT V7630
Output this address to V7630, the location of the pointer to the Profile Parameter Table.
LD K103
Load the constant K103 which is required to select pulse and direction for physical Y0 and Y1 functions, respectively (Use K3 if your application needs CW and CCW).
OUT V7632
Output this constant to V7632, configuring the pulse output type.
LD K1006
Load the constant K1006 which is required to select filtered inputs with a 10 mS filter time constant.
OUT V7634
Output this constant to V7634, configuring X0.
OUT V7635
Output this constant to V7635, configuring X1.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.

* If the Locate Parameter Table is not used y ou must remove both the LDA function and the OUT function below it.

Program Example Cont'd



Load the constant K2000 which is required to select Velocity Profile. This data word contains no velocity information in the case of velocity mode.

Output this constant to V3630, the location of the Profile Select setup register.

Load the constant K80000000 which selects CCW direction for Velocity Profiles. Don't forget to use double word size (8-digit BCD position value).

Output this constant to V3631 and V3632, the location of the Target Position double-word register.

Load the constant K10 which is required to select an initial velocity of 100 pps (uses x10 multiplier).

Output this constant to V3633, the location of the velocity parameter register. After the program is running, we can write here again, using discrete input switches.

We use a spare filtered input to allow the operator to start the profile. When the operator turns X1 ON, logical output Y0 starts the profile. The operator must maintain X1 on until the profile is complete.

Load the constant K50 which is required to select a velocity of 500 pps when the operator closes X2.

Output this constant to V3633, the location of the velocity parameter register. The speed will change immediately.

Load the constant K200 which is required to select a velocity of 2000 pps when the operator closes X3.

Output this constant to V3633, the location of the velocity parameter register. The speed will change immediately.

Load the constant K600 which is required to select a velocity of 6000 pps when the operator closes X4.

Output this constant to V3633, the location of the velocity parameter register. The speed will change immediately.

Automatic Trapezoidal Profile Error Codes

The Profile Parameter Table starting at V3630 (default location) defines the profile. Certain numbers will result in an error when the HSIO attempts to use the parameters to execute a move profile. When an error occurs, the HSIO writes an error code in V3636.

Most errors can be corrected by rechecking the Profile Parameter Table values. The error is automatically cleared at powerup and at Program-to-Run Mode transitions.

Error Code	Error Description
0000	No error
0010	Requested profile type code is invalid (must use 4 to 6 or C to F)
0011	Interrupt is selected for absolute mode
0020	Target Velocity is not in BCD
0021	Target Velocity is specified to be less than 40 pps
0022	Target Velocity is specified to be greater than 10,000 pps
0030	Target Position value is not in BCD
0031	Target Position value is zero
0032	Direction Select is not 0 or 80000000.
0040	Starting Velocity is not in BCD
0041	Starting Velocity is specified to be less than 40 pps
0042	Starting Velocity is specified to be greater than 10,000 pps
0050	Acceleration Time is not in BCD
0051	Acceleration Time is zero
0052	Acceleration Time is greater than 10 seconds
0060	Deceleration Time is not in BCD
0061	Deceleration Time is zero
0062	Deceleration Time is greater than 10 seconds
0070	Ending Velocity is not BCD
0071	Ending Velocity is specified to be less than 40 pps
0072	Ending Velocity is specified to be greater than 1,000 pps
0073	Ending Velocity is specified to be greater than Target Velocity

Troubleshooting Guide for Mode 30

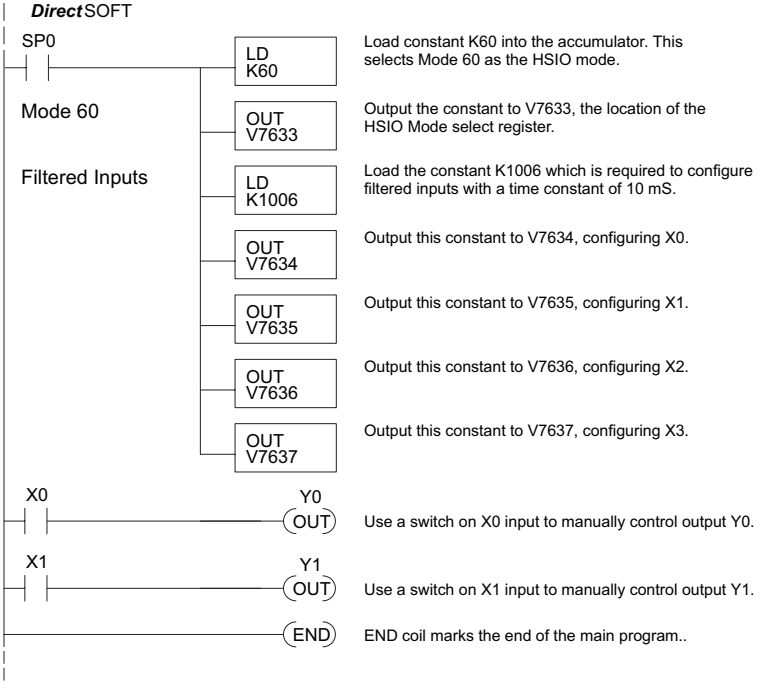
If you're having trouble with Mode 30 operation, please study the following symptoms and possible causes. The most common problems are listed below.

Symptom: The stepper motor does not rotate.

Possible causes:

1. **Configuration –** Verify that the HSIO actually generates pulses on outputs Y0 and Y1. Watch the status LEDs for Y0 and Y1 when you start a motion profile. If the LEDs flicker on and off or are steadily on, the configuration is probably correct.
2. **Programming error –** If there are no pulses on Y0 or Y1 you may have a programming error. Check the contents of V3636 for an error code that may be generated when the PLC attempts to do the move profile. Error code descriptions are given above.
3. **Check target value –** The profile will not pulse if the count value is equal to the target value (ex. count =0, target=0).

4. **Wiring** – Verify the wiring to the stepper motor is correct. Remember the signal ground connection from the PLC to the motion system is required.
5. **Motion system** – Verify that the drive is powered and enabled. To verify the motion system is working, you can use Mode 60 operation (normal PLC inputs/outputs) as shown in the test program below. With it, you can manually control Y0 and Y1 with X0 and X1, respectively. Using an input simulator is ideal for this type of manual debugging. With the switches you can single-step the motor in either direction. If the motor will not move with this simple control, Mode 30 operation will not be possible until the problem with the motor drive system or wiring is corrected.


DirectSOFT
SP0
LD K60
Load constant K60 into the accumulator. This selects Mode 60 as the HSIO mode.
Mode 60
OUT V7633
Output the constant to V7633, the location of the HSIO Mode select register.
Filtered Inputs
LD K1006
Load the constant K1006 which is required to configure filtered inputs with a time constant of 10 mS.
OUT V7634
Output this constant to V7634, configuring X0.
OUT V7635
Output this constant to V7635, configuring X1.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.
X0
Y0
OUT
Use a switch on X0 input to manually control output Y0.
X1
Y1
OUT
Use a switch on X1 input to manually control output Y1.
END
END coil marks the end of the main program..

6. **Memory Error** – HSIO configuration parameters are stored in the CPU system memory. Corrupted data in this memory area can sometimes interfere with proper HSIO operation. If all other corrective actions fail, initializing the scratchpad memory may solve the problem. With *Direct*SOFT, select **PLC > Setup > Initialize Scratch Pad** from the Menu bar.

Symptom: The motor turns in the wrong direction.

Possible causes:

1. **Wiring** – If you have selected CW and CCW type operation, just swap the wires on Y0 and Y1 outputs.
2. **Direction control** – If you have selected Pulse and Direction type operation, just change the direction bit to the opposite state.

Mode 40: High-Speed Interrupts

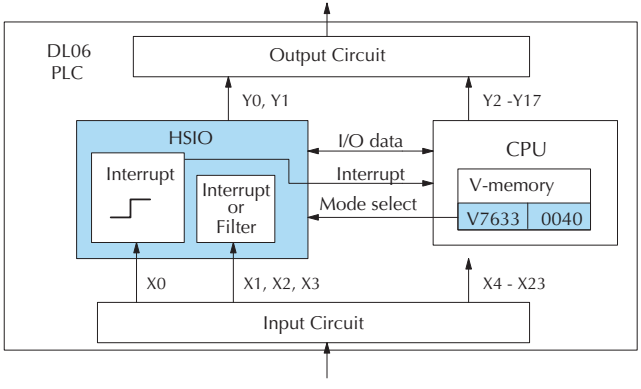
Purpose

The HSIO Mode 40 provides a high-speed interrupt to the ladder program. This capability is provided for your choice of the following application scenarios:

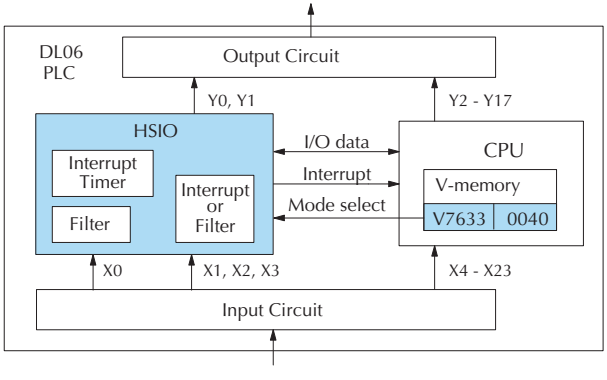
- External events need to trigger an interrupt subroutine in the CPU. Using immediate I/O instructions in the subroutine is typical.
- An interrupt routine needs to occur on a timed basis which is different from the CPU scan time (either faster or slower). The timed interrupt is programmable, from 5 to 999 mS.

Functional Block Diagram

The HSIO circuit creates the high-speed interrupt to the CPU. The following diagram shows the external interrupt option, which uses X0. In this configuration X1, X2 and X3 are external interrupts or normal filtered inputs.

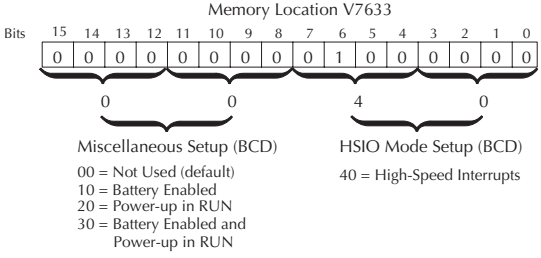


Alternately, you may configure the HSIO circuit to generate interrupts based on a timer, as shown below. In this configuration, inputs X0 is a filtered input.



Setup for Mode 40

Recall that V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 40 in the lower byte of V7633 to select high-speed interrupts.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0
4 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
40 = High-Speed Interrupts

Choose the most convenient method of programming V7633 from the following:

- Include load and out instructions in your ladder program
- *Direct*SOFT's memory editor
- Use the Handheld Programmer D2–HPP

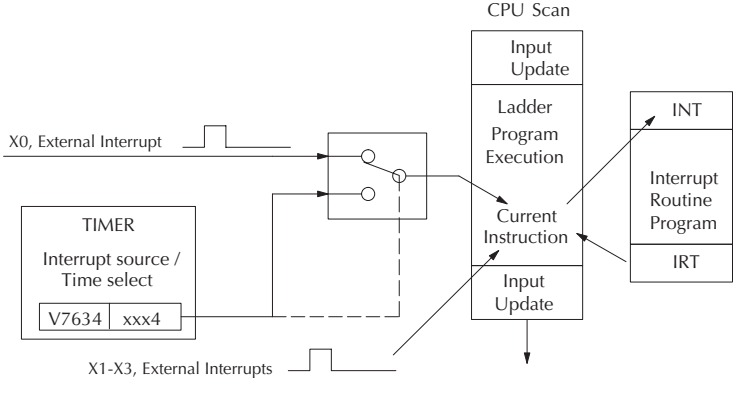
We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.

Interrupts and the Ladder Program

Refer to the drawing below. The source of the interrupt may be external (X0 - X3). An internal timer can be used instead of X0 as the interrupt source. The setup parameter in V7634 serves a dual purpose:

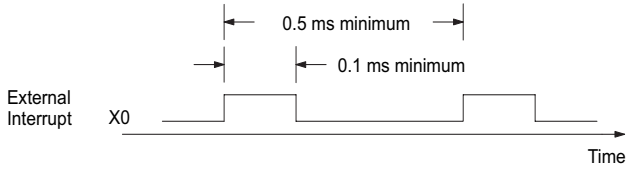
- It selects between the two interrupt sources (external or internal timer). The timed interrupt can only be used with X0.
- In the case of the timer interrupt, it programs the interrupt timebase between 5 and 999 mS.

The resulting interrupt uses label INT 0, 1, 2 or 3 in the ladder program. Be sure to include the Enable Interrupt (ENI) instruction at the beginning of your program. Otherwise, the interrupt routine will not be executed.



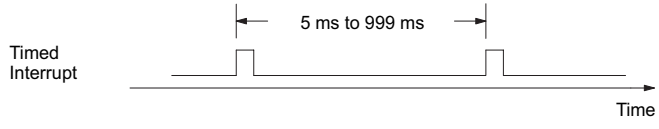
External Interrupt Timing Parameters

External interrupt signals must meet certain timing criteria to guarantee an interrupt will result. Refer to the timing diagram below. The minimum pulse width is 0.1 ms. There must be some delay before the next interrupt pulse arrives, such that the interrupt period cannot be smaller than 0.5 ms.



Timed Interrupt Parameters

When the timed interrupt is selected, the HSIO generates the interrupt to ladder logic. There is no interrupt pulse width in this case, but the interrupt period can be adjusted from 5 to 999 ms.



Input / Timed INT Configuration

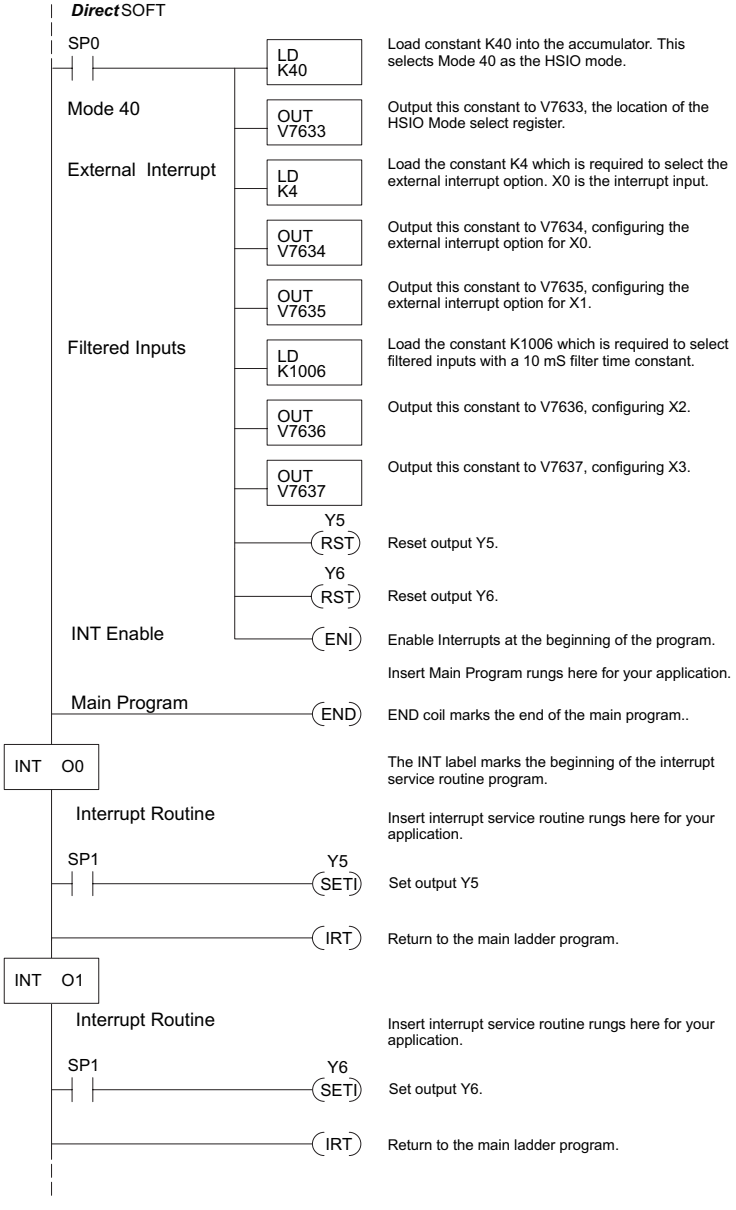
The configurable discrete input options for High-Speed Interrupt Mode are listed in the table below. Input X0 is the external interrupt when "0004" is in V7634. If you need a timed interrupt instead, then V7634 contains the interrupt time period, and input X0 becomes a filtered input (uses X1's filter time constant by default). Inputs X0, X1, X2, and X3, can be filtered inputs, having individual configuration registers and filter time constants, interrupt inputs or counter inputs.

Input	Configuration Register	Function	Hex Code Required
X0	V7634	External Interrupt	0004 (default)
		Timed Interrupt	xxx4, xxx = INT timebase 5 - 999 ms (BCD)
X1	V7635	Interrupt	0004 (default)
		Pulse Input	0005
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)
X2	V7636	Interrupt	0004 (default)
		Pulse Input	0005
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)
X3	V7637	Interrupt	0004 (default)
		Pulse Input	0005
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)

If you are only using *one* of the points for an interrupt, you may want to select a different *main* mode (i.e. 10, 20, 30, 50, or 60); and then, just configure one of the terminals not taken as an interrupt. For example, you might want to configure your CPU for the UP counter mode (Mode 10) and use point 03 for a high speed interrupt. You should read the individual sections for any alternate mode you might choose. There you will find instructions on how to select a high speed interrupt as a secondary feature.

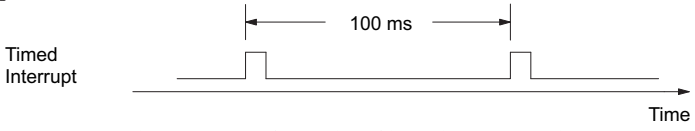
Program Example 1: External Interrupt

The following program selects Mode 40, then selects the external interrupt option for inputs X0 and X1. Inputs X2 and X3 are configured as filtered inputs with a 10 ms time constant. The program is otherwise generic, and may be adapted to your application.

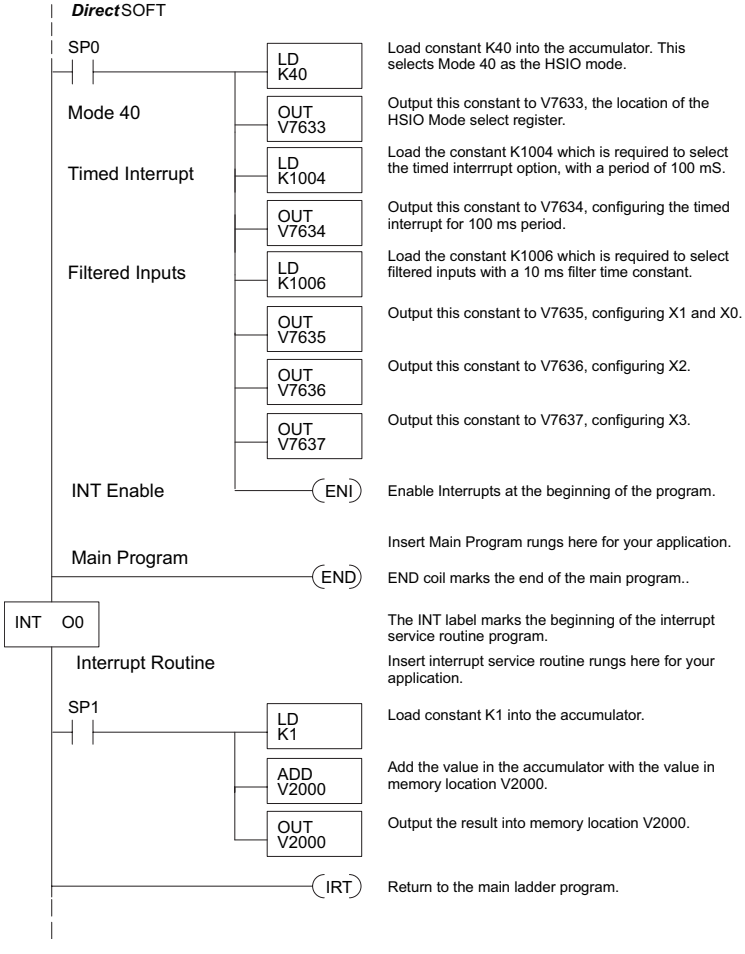

DirectSOFT
SP0
LD K40
Load constant K40 into the accumulator. This selects Mode 40 as the HSIO mode.
Mode 40
OUT V7633
Output this constant to V7633, the location of the HSIO Mode select register.
External Interrupt
LD K4
Load the constant K4 which is required to select the external interrupt option. X0 is the interrupt input.
OUT V7634
Output this constant to V7634, configuring the external interrupt option for X0.
OUT V7635
Output this constant to V7635, configuring the external interrupt option for X1.
Filtered Inputs
LD K1006
Load the constant K1006 which is required to select filtered inputs with a 10 mS filter time constant.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.
Y5
RST
Reset output Y5.
Y6
RST
Reset output Y6.
INT Enable
ENI
Enable Interrupts at the beginning of the program.
Insert Main Program rungs here for your application.
Main Program
END
END coil marks the end of the main program..
INT O0
The INT label marks the beginning of the interrupt service routine program.
Interrupt Routine
Insert interrupt service routine rungs here for your application.
SP1
Y5
SET
Set output Y5
IRT
Return to the main ladder program.
INT O1
Interrupt Routine
Insert interrupt service routine rungs here for your application.
SP1
Y6
SET
Set output Y6.
IRT
Return to the main ladder program.

Program Example 2: Timed Interrupt

The following program selects Mode 40, then selects the timed interrupt option, with an interrupt period of 100 ms.



Inputs X0, X1, X2, and X3, are configured as filtered inputs with a 10 ms time constant. Note that X0 uses the time constant from X1. The program is otherwise generic, and may be adapted to your application.


DirectSOFT
SP0
LD K40
Load constant K40 into the accumulator. This selects Mode 40 as the HSIO mode.
Mode 40
OUT V7633
Output this constant to V7633, the location of the HSIO Mode select register.
Timed Interrupt
LD K1004
Load the constant K1004 which is required to select the timed interrrupt option, with a period of 100 mS.
OUT V7634
Output this constant to V7634, configuring the timed interrupt for 100 ms period.
Filtered Inputs
LD K1006
Load the constant K1006 which is required to select filtered inputs with a 10 ms filter time constant.
OUT V7635
Output this constant to V7635, configuring X1 and X0.
OUT V7636
Output this constant to V7636, configuring X2.
OUT V7637
Output this constant to V7637, configuring X3.
INT Enable
ENI
Enable Interrupts at the beginning of the program.
Insert Main Program rungs here for your application.
Main Program
END
END coil marks the end of the main program..
INT O0
The INT label marks the beginning of the interrupt service routine program.
Interrupt Routine
Insert interrupt service routine rungs here for your application.
SP1
LD K1
Load constant K1 into the accumulator.
ADD V2000
Add the value in the accumulator with the value in memory location V2000.
OUT V2000
Output the result into memory location V2000.
IRT
Return to the main ladder program.

NOTE: *X0 Cannot be used in the main program logic; however, using X0 to set C10, for instance, will allow the use of C10 in the main program logic. Do not forget to reset C10.*

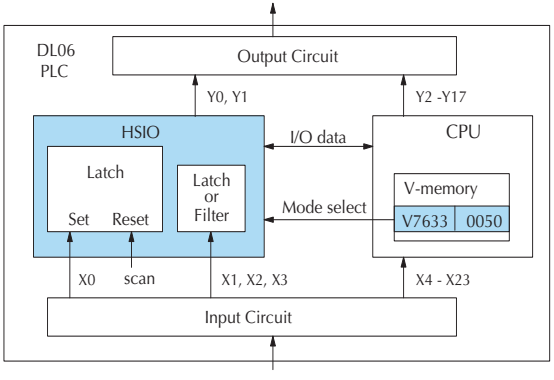
Mode 50: Pulse Catch Input

Purpose

The HSIO circuit has a pulse-catch mode of operation. It monitors the signal on inputs X0 - X3, preserving the occurrence of a narrow pulse. The purpose of the pulse catch mode is to enable the ladder program to *see* an input pulse which is shorter in duration than the current scan time. The HSIO circuit latches the input event on input X0 - X3 for one scan. This contact automatically goes off after one scan.

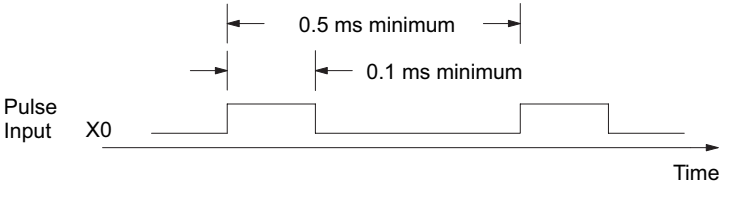
Functional Block Diagram

Refer to the block diagram below. When the lower byte of HSIO Mode register V7633 contains a BCD "50", the pulse catch mode in the HSIO circuit is enabled. X0 - X3 automatically become the pulse catch inputs, which set the latch on each rising edge. The HSIO resets the latch at the end of the next CPU scan. Inputs X1 X2, and X3 can be filtered discrete inputs, also.



Pulse Catch Timing Parameters

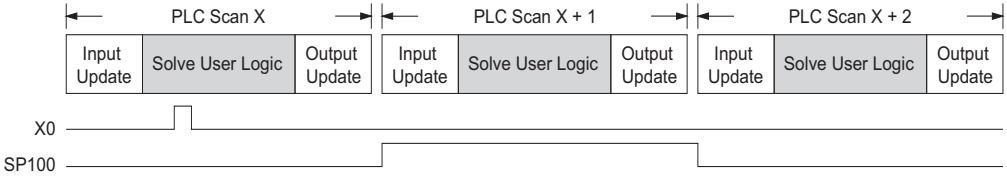
Signal pulses at X0 - X3 must meet certain timing criteria to guarantee a pulse capture will result. Refer to the timing diagram below. The input characteristics of X0 are fixed (it is not a programmable filtered input). The minimum pulse width is 0.1 ms. There must be some delay before the next pulse arrives, such that the pulse period cannot be smaller than 0.5 ms. If the pulse period is smaller than 0.5 ms, the next pulse will be considered part of the current pulse.



NOTE: *The pulse catch and filtered input functions are opposite in nature. The pulse catch feature seeks to capture narrow pulses, while the filter input feature seeks to reject narrow pulses.*

When to use Pulse Catch Mode

Use the pulse catch mode for applications where the input (e.g. X0) can not be used in the user program because the pulse width is very narrow. Use SP100 instead of X0. The SP100 contact stays on through the next scan, as shown above. Even if X0 is on for more than one scan, SP100 is still on for only one scan.

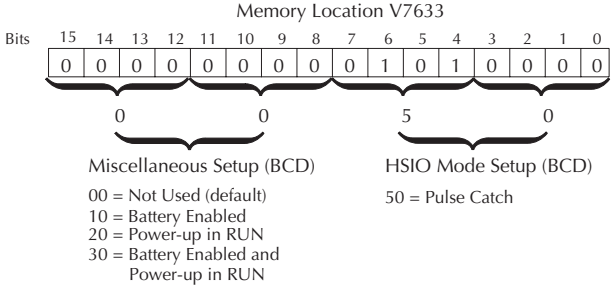


The status relay for X0 is SP100. The other status relays are shown in the table below.

Input	Status Relay
X0	SP100
X1	SP101
X2	SP102
X3	SP103

Setup for Mode 50

Recall that V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 50 in the lower byte of V7633 to select the High-Speed Counter Mode.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0
5 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
50 = Pulse Catch

Choose the most convenient method of programming V7633 from the following:

- Include load and out instructions in your ladder program
- ***Direct***SOFT's memory editor
- Use the Handheld Programmer D2–HPP

We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.

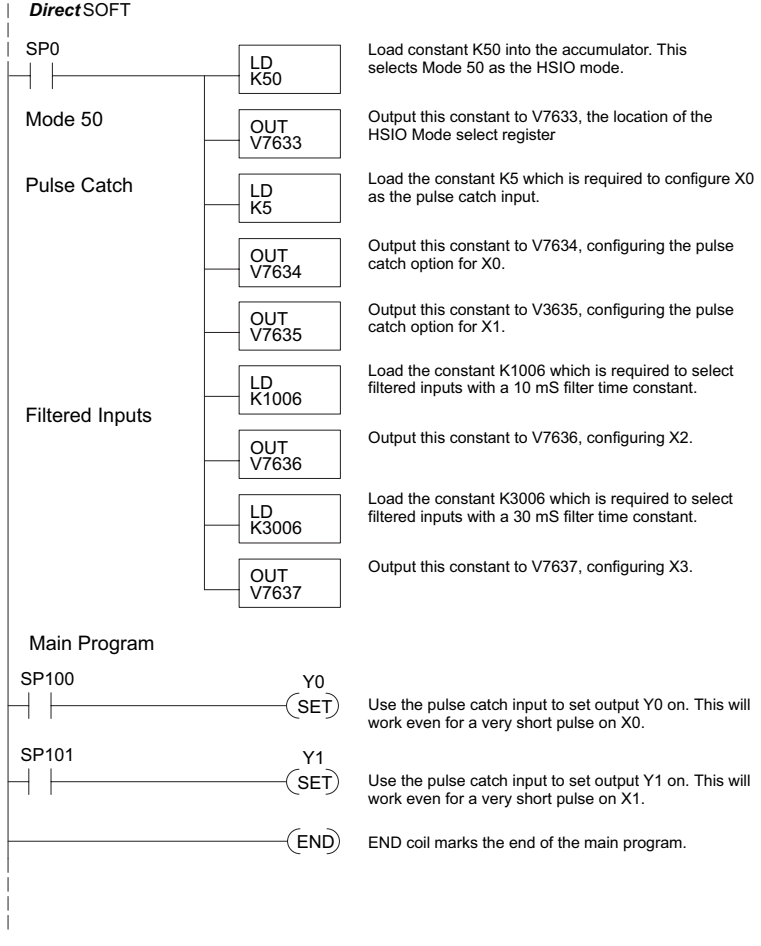
X Input Configuration

The configurable discrete input options for Pulse Catch Mode are listed in the table below. Each input has its own configuration register and filter time constant.

Input	Configuration Register	Function	Hex Code Required
X0	V7634	Pulse Catch Input	0005 (default)
X1	V7635	Interrupt	0004
		Pulse Catch Input	0005 (default)
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)
X2	V7636	Interrupt	0004
		Pulse Catch Input	0005 (default)
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)
X3	V7637	Interrupt	0004
		Pulse Catch Input	0005 (default)
		Filtered Input	xx06 (xx = filter time) 0 - 99 ms (BCD)

Program Example 1: Pulse Catch

The following program selects Mode 50, then programs the pulse catch code for X0 and X1. Inputs X2, and X3 are configured as filtered inputs with 10 and 30 mS time constants respectively. The program is otherwise generic, and may be adapted to your application.


DirectSOFT
SP0
LD K50
Load constant K50 into the accumulator. This selects Mode 50 as the HSIO mode.
Mode 50
OUT V7633
Output this constant to V7633, the location of the HSIO Mode select register
Pulse Catch
LD K5
Load the constant K5 which is required to configure X0 as the pulse catch input.
OUT V7634
Output this constant to V7634, configuring the pulse catch option for X0.
OUT V7635
Output this constant to V3635, configuring the pulse catch option for X1.
LD K1006
Load the constant K1006 which is required to select filtered inputs with a 10 mS filter time constant.
Filtered Inputs
OUT V7636
Output this constant to V7636, configuring X2.
LD K3006
Load the constant K3006 which is required to select filtered inputs with a 30 mS filter time constant.
OUT V7637
Output this constant to V7637, configuring X3.
Main Program
SP100
Y0
SET
Use the pulse catch input to set output Y0 on. This will work even for a very short pulse on X0.
SP101
Y1
SET
Use the pulse catch input to set output Y1 on. This will work even for a very short pulse on X1.
END
END coil marks the end of the main program.

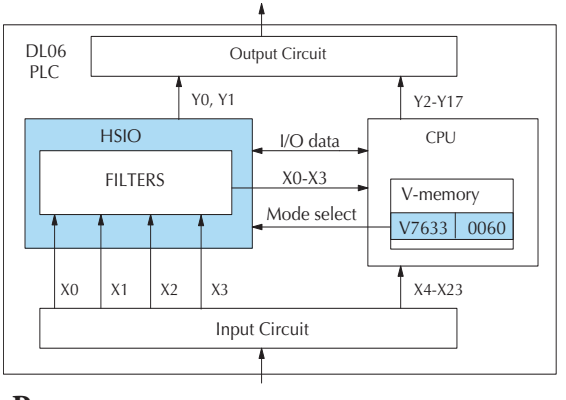
Mode 60: Discrete Inputs with Filter

Purpose

The last mode we will discuss for the HSIO circuit is Mode 60, Discrete Inputs with Filter. The purpose of this mode is to allow the input circuit to reject narrow pulses and accept wide ones, as viewed from the ladder program. This is useful in especially noisy environments or other applications where pulse width is important. In all other modes in this appendix, X0 to X3 usually support the mode functions as special inputs. Only spare inputs operate as filtered inputs by default. Now in Mode 60, all four inputs X0 through X3 function only as discrete filtered inputs.

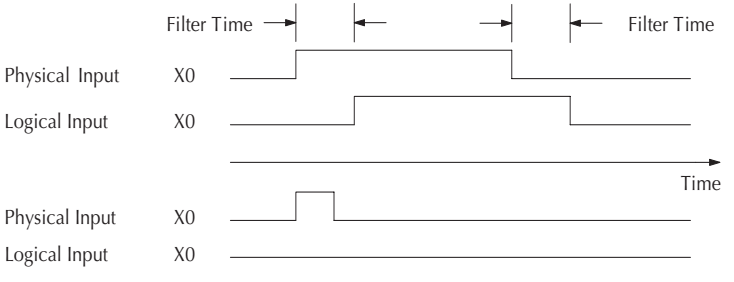
Functional Block Diagram

Refer to the block diagram below. When the lower byte of HSIO Mode register V7633 contains a BCD "60", the input filter in the HSIO circuit is enabled. Each input X0 through X3 has its own filter time constant. The filter circuit assigns the outputs of the filters as logical references X0 through X3.



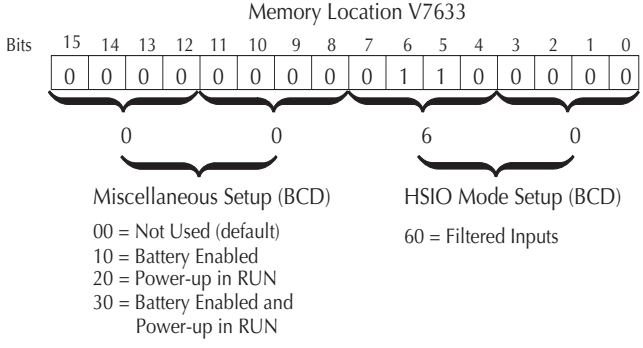
Input Filter Timing Parameters

Signal pulses at inputs X0 – X3 are filtered by using a delay time. In the figure below, the input pulse on the top line is longer than the filter time. The resultant logical input to ladder is phase-shifted (delayed) by the filter time on both rising and falling edges. In the bottom waveforms, the physical input pulse width is smaller than the filter time. In this case, the logical input to the ladder program remains in the OFF state (input pulse was filtered out).



Setup for Mode 60

Recall that V7633 is the HSIO Mode Select register. Refer to the diagram below. Use BCD 60 in the lower byte of V7633 to select the High-Speed Counter Mode.


Memory Location V7633
Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
0 0 6 0
Miscellaneous Setup (BCD)
00 = Not Used (default)
10 = Battery Enabled
20 = Power-up in RUN
30 = Battery Enabled and Power-up in RUN
HSIO Mode Setup (BCD)
60 = Filtered Inputs

Choose the most convenient method of programming V7633 from the following:

- Include load and out instructions in your ladder program
- *Direct*SOFT's memory editor
- Use the Handheld Programmer D2–HPP

We recommend using the first method above so that the HSIO setup becomes an integral part of your application program. An example program later in this section shows how to do this.

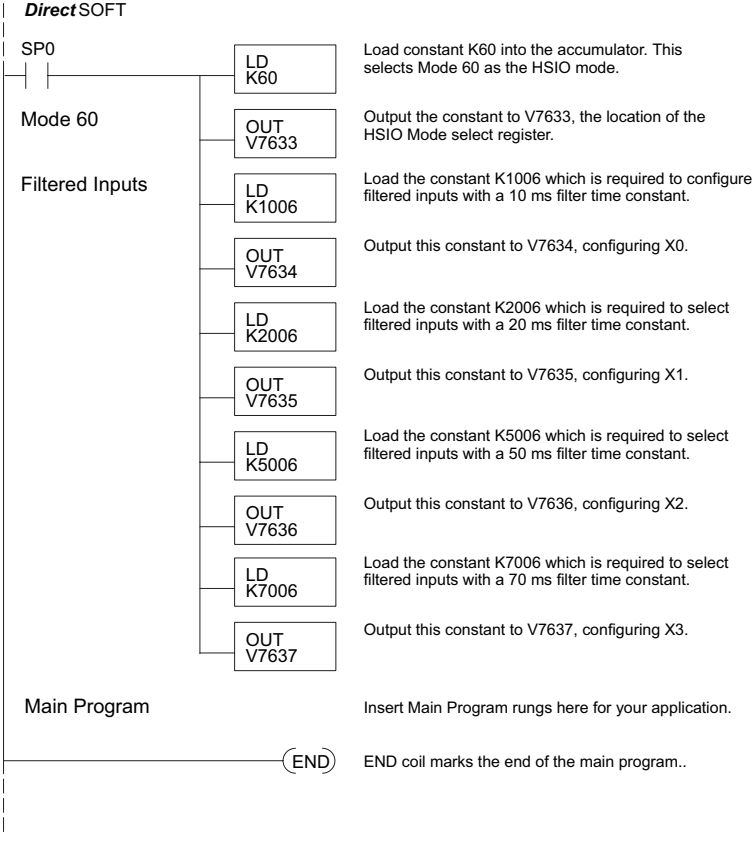
X Input Configuration

The configurable discrete input options for Discrete Filtered Inputs Mode are listed in the table below. The filter time constant (delay) is programmable from 0 to 99 mS (the input acts as a normal discrete input when the time constant is set to 0). The code for this selection occupies the upper byte of the configuration register in BCD. We combine this number with the required "06" in the lower byte to get "xx06", where xx = 0 to 99. Input X0, X1, X2, and X3 can only be filtered inputs. Each input has its own configuration register and filter time constant.

Input	Configuration Register	Function	Hex Code Required
X0	V7634	Filtered Input	xx06 (xx = filter delay time) 0 - 99 ms (BCD) (default)
X1	V7635	Filtered Input	xx06 (xx = filter delay time) 0 - 99 ms (BCD) (default)
X2	V7636	Filtered Input	xx06 (xx = filter delay time) 0 - 99 ms (BCD) (default)
X3	V7637	Filtered Input	xx06 (xx = filter delay time) 0 - 99 ms (BCD) (default)

Program Example: Filtered Inputs

The following program selects Mode 60, then programs the filter delay time constants for inputs X0, X1, X2, and X3. Each filter time constant is different, for illustration purposes. The program is otherwise generic, and may be adapted to your application.


DirectSOFT
SP0
LD K60
Load constant K60 into the accumulator. This selects Mode 60 as the HSIO mode.
Mode 60
OUT V7633
Output the constant to V7633, the location of the HSIO Mode select register.
Filtered Inputs
LD K1006
Load the constant K1006 which is required to configure filtered inputs with a 10 ms filter time constant.
OUT V7634
Output this constant to V7634, configuring X0.
LD K2006
Load the constant K2006 which is required to select filtered inputs with a 20 ms filter time constant.
OUT V7635
Output this constant to V7635, configuring X1.
LD K5006
Load the constant K5006 which is required to select filtered inputs with a 50 ms filter time constant.
OUT V7636
Output this constant to V7636, configuring X2.
LD K7006
Load the constant K7006 which is required to select filtered inputs with a 70 ms filter time constant.
OUT V7637
Output this constant to V7637, configuring X3.
Main Program
Insert Main Program rungs here for your application.
END
END coil marks the end of the main program..